99/86

ACID DEPOSITION CONTROL ACT OF 1986
(PART 2)

HEARING

BEFORE THE

SUBCOMMITTEE ON
HEALTH AND THE ENVIRONMENT

OF THE

COMMITTEE ON ENERGY AND COMMERCE
HOUSE OF REPRESENTATIVES

NINETY-NINTH CONGRESS

SECOND SESSION

H.R. 4567

A BILL TO AMEND THE CLEAN AIR ACT TO REDUCE ACID DEPOSITION, AND FOR OTHER PURPOSES

MAY 1, 1986

Serial No. 99-86

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ACID DEPOSITION CONTROL ACT OF 1986

THURSDAY, MAY 1, 1986

House of Representatives,
Committee on Energy and Commerce,
Subcommittee on Health and the Environment,
Washington, DC.

The subcommittee met, pursuant to notice, at 9:40 a.m., in room 2123, Rayburn House Office Building, Hon. Henry A. Waxman (chairman) presiding.

Mr. Waxman. The meeting of the subcommittee will please come to order. Today we are going to continue with our hearings on the subject of acid rain regulation and control.

For our first panel, I would like to call these people forward. Mr. Bernard I. Robertson, director, Powertrain Engineering, Chrysler Corp.; Dr. Richard L. Klimisch, executive director, Environmental Activities Staff, General Motors; Mr. Donald Buist, director of Automotive Emissions and Fuel Economy Office, Ford Motor Co.; Mr. Stuart Perkins, director of Federal affairs, American Motors; Mr. George C. Nield, president, Automobile Importers of America; Mr. Dietmar Haenchen, executive engineer, Vehicle Regulations Department, Volkswagen of America.

We are pleased to welcome you to our subcommittee hearing today. Your prepared statements will be made a part of the record in full but what we are going to ask of each of you and have to be very rigid in our time allocations is to summarize your statement in no more than 5 minutes.

We are going to operate on a very strict 5-minute rule both for our witnesses and for members of the subcommittee who wish to ask questions. We have a timer and when the bell rings, the time is up and we will have to move on as unsatisfactory as that is as a way to get a full discussion of these issues but that is unfortunately the way we will have to operate.

Mr. Robertson, why don't we start with you. Please be sure the microphone is on and we look forward to hearing from you.

STATEMENTS OF BERNARD I. ROBERTSON, DIRECTOR, POWERTRAIN ENGINEERING, CHRYSLER CORP.; RICHARD L. KLIMISCH, EXECUTIVE DIRECTOR, ENVIRONMENTAL ACTIVITIES STAFF, GENERAL MOTORS CORP.; DONALD R. BUIST, DIRECTOR OF AUTOMOTIVE EMISSIONS AND FUEL ECONOMY OFFICE, FORD MOTOR CO.; STUART R. PERKINS, DIRECTOR OF FEDERAL GOVERNMENT AFFAIRS, AMERICAN MOTORS CORP.; GEORGE C. NIELD, PRESIDENT, AUTOMOBILE IMPORTERS OF AMERICA, INC.; AND DIETMAR HAENCHEN, EXECUTIVE ENGINEER, VEHICLE REGULATIONS DEPARTMENT, VOLKSWAGEN OF AMERICA, INC.

Mr. ROBERTSON. Good morning. Thank you, Mr. Chairman, for this opportunity to comment on House rule 4567. I will attempt to just pick out the highlights of my full testimony.

The act has, as you know, has for many years had a very significant impact on the automobile industry and Chrysler has played a key role in the auto industry's development of the emission control technology needed to meet the stringent requirements of the act as it stands today.

The motor vehicle emission standards proposed in this bill present us with yet another challenge. Although some of the proposed standards appear to be achievable, others are not technologically achievable in the proposed timeframe or in the foreseeable future.

Chrysler believes the evidence is clear that tighter control of NO_x emissions from trucks or cars is unnecessary and that these requirements will contribute little to improving public health, air quality or the control of acid deposition.

We are troubled by the fact that the proposed legislation sites no specific health of environmental justifications for the control levels proposed.

Tighter standards would however increase truck costs, increase fuel consumption and degrade engine power, especially on larger trucks.

The proposed 0.7 grams per mile NO_x standard for passenger cars in 1989 would seem on the surface to not present a major problem because this standard is already being met in California. California, however, presently requires only seven grams per mile of CO. Meeting 0.7 NO_x together with the Federal 3.4 CO standard has never been done and by done, I mean, compliance with all of the requirements of the act including in use surveillance.

It represents a difficult technical challenge requiring both higher precious metal loadings and more expensive engine control systems. If 0.7 NO_x is really needed, serious consideration should be given to adopting the current California CO standard.

House rule 4567 would also impose more stringent NO_x standards on light-duty trucks and heavy-duty engines starting in 1988 model year. We must point out that this requirement would not provide us with sufficient leadtime for implementation, not even the 18 months currently provided under the Clean Air Act.

Furthermore, the 1.2 grams per mile NO_x standard for all light trucks would present serious difficulties for the heavier models.

The proposed reduction in heavy-duty truck NO_x standards to 1.7 grams per break horsepower-hour in 1988 is almost 70 percent below the most stringent standard currently scheduled to take effect in 1991.

To put that in perspective, the 1988 requirement currently on the books is for a 43-percent drop in 1 year. This bill would make it an 84-percent drop in 1 year.

This requirement is impossible to meet with any technology we know of or expect to develop. I might add that we are already adding dual air pumps, dual exhaust systems, dual catalysts, January 1, 1987, and adding additional hardware for 1988 at a very, very high cost before implementation of these proposed standards.

The HC emission standards proposed for light trucks in 1990 could be possible to achieve using the best control technology now used on cars and certain California trucks. Please note, however, that compliance with those more stringent truck standards in California today levies a penalty of up to 2.6 miles per gallon in fuel economy and a sticker price increase of $235.00. We are most reluctant to see customers in all 50 States burdened with those penalties without more rigorous determination of the need.

Although HC emissions are unrelated to acid rain. This bill would also appear to mandate nationwide gasoline refueling controls either as an onboard system or stage II controls at the pump.

The fact is that there is no demonstrated need for nationwide controls of this sort. The Health Effects Institute has specifically investigated this issue and not found any health hazard to exist for people refueling their own motor vehicles.

Control of HC refueling vapors is needed only in order to improve compliance with ozone requirements in local nonattainment areas. This can be done most quickly, effectively and at least cost by selective regulation of gasoline volatility and stage II gas pump controls. By contrast, equipping the entire vehicle population with new and elaborate evaporative control systems would be an inexorably slow and extremely costly way to address ozone problems.

In summary, Chrysler believes that the automotive industry has already accomplished more than its share by reducing motor vehicle emissions to the extent we have. We have worked hard to achieve these reductions while improving fuel efficiency roughly 3 percent per year and while delivering traditional levels of driveability and performance and we are extremely proud of our accomplishments.

The proposed standards would require substantially increased effort and would impose additional expense and inefficiency on all Americans without contributing any meaningful improvements to the environment.

Thank you very much.

[The prepared statement of Mr. Robertson follows:]

CHRYSLER
CORPORATION

Statement by Bernard I. Robertson, Director of Powertrain Engineering, Chrysler Corporation, before the Subcommittee on Health and the Environment, for the Hearing on H.R. 4567, the "Acid Deposition Control Act of 1986," May 1, 1986, Washington, D.C.

Thank you, Mr. Chairman, for the opportunity to comment on H.R. 4567, which proposes amendments to the Clean Air Act.

The Act has, for many years, had a very significant impact on the automotive industry, and Chrysler has played a key role in the auto industry's development of the emission control technology needed to meet the requirements of the Act. We have accomplished reductions of passenger car hydrocarbons by 96%, carbon monoxide also by 96%, and nitrogen oxides (which are much more difficult to control) by 75%. This has proven to be a formidable task, requiring considerable resources to solve the many technical problems that stood in the way of achieving increasingly more stringent emission standards. Control systems have evolved from calibration revisions to air injection pumps, to oxidation catalysts and unleaded fuel, to exhaust gas recirculation; and recently to computerized engine and fuel controls, exhaust oxygen sensors, new three-way catalysts, fuel injection, and so on.

The motor vehicle emission standards proposed in H.R. 4567 present us with yet another challenge. Although some of the standards appear to be achievable, others are not technologically feasible in the proposed time-frame, or in the foreseeable future.

Chrysler believes the evidence is clear that tighter control of NO_x emissions from trucks or cars is unnecessary, and that these requirements will contribute little to improving public health, air quality, or the control of acid deposition. We are troubled by the fact that the proposed legislation cites no specific health or environmental justifications for the control levels proposed.

The air quality standard for nitrogen dioxide is already being met everywhere in the United States except in the Los Angeles area. Furthermore, NO_x emissions from motor vehicles contribute very little to the acid deposition problem. Based on the most recent EPA emissions inventory for all sources of NO_x, trucks and cars each constitute no more than five percent of the total precursor pollutants responsible for acid deposition. The proposed tightening in standards over the strict levels already established would not improve this situation to any appreciable degree. Tighter standards would, however, increase truck costs, increase fuel consumption, and degrade engine power, especially on larger trucks.

The proposed 0.7 g/mi NO_x standard for passenger cars in 1989 would seem on the surface to not present a major problem because this standard is already being met in California. California, however, presently requires only 7.0 g/mi CO. Meeting 0.7 NOx with the federal 3.4 CO standard has never been done, and represents a difficult technical challenge, requiring both higher precious metal loadings and more expensive engine control systems. If 0.7 NOx is really needed, serious consideration should be given to adopting the current California CO standard.

H.R. 4567 would also impose more stringent NO_x standards on light-duty trucks and heavy-duty engines starting in 1988 model year. We must point out that this requirement would not provide us with sufficient leadtime for implementation, not even the 18 months provided under the present Clean Air Act. The 1.2 g/mi NO_x standard for all light trucks would present serious difficulties for the heavier models.

The proposed reduction in heavy-duty truck NOx emissions to 1.7 g/BHP-hr in 1988 model year is almost 70 percent below the most stringent standard scheduled to take effect in 1991. This requirement is impossible to meet with any technology we know of or expect to develop.

The HC emission standards proposed for light trucks in 1990 could be possible to achieve using the best control technology now used on cars and certain California trucks. Please note, however, that compliance with those more stringent truck standards in California levies a penalty of up to 2.6 mpg in fuel economy and a sticker price increase of $235. We are most reluctant to see customers in all 50 states burdened with these penalties without more rigorous determination of the need.

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Control of HC refueling vapors is needed only in order to improve compliance with ozone requirements in local non-attainment areas. This can be done most quickly, effectively, and at least cost by selective regulation of gasoline volatility and Stage II gas pump controls. By contrast, equipping the entire vehicle population with new and elaborate evaporative control systems would be an inexorably slow and extremely costly way to address ozone problems.

Summary

In conclusion, Chrysler believes that the automotive industry has already accomplished more than its share by reducing motor vehicle emissions to the extent we have. We have worked hard to achieve these reductions while improving fuel efficiency roughly 3% per year and while delivering traditional levels of driveability and performance. We are proud of our accomplishments. The proposed standards would require substantially increased effort, and would impose additional expense and inefficiency on all Americans without contributing any meaningful improvements to the environment.

* * *

Mr. **Waxman**. Thank you very much, Mr. Robertson, for your testimony.

Mr. Klimisch.

STATEMENT OF RICHARD L. KLIMISCH

Mr. **Klimisch**. We appreciate this opportunity to testify on H.R. 4567. I came to General Motors Research Laboratories in 1968 as the first GM expert on catalysis. The project that was started at that time by our president Ed Cole ultimately led to the installation of catalytic converters on all our cars in 1975 and currently catalysts are installed on virtually every light-duty vehicle sold in this country.

That device has made it possible for us to achieve a 96-percent reduction of carbon monoxide and hydrocarbons and a 76-percent reduction of nitrogen oxides or NO_x as compared to uncontrolled cars.

Since 1975, I spent my time involved in research to investigate the causes and effects of air pollution. My comments today will focus on those aspects of H.R. 4567 related to our products and our manufacturing operation.

The principal connection between vehicles and acid rain is through NO_x emissions. Cars and trucks each produce about 15 percent of the NO_x emissions in this country. Some of this NO_x is converted to nitric acid but the ultimate deposition of the derived nitrogen containing species has some interesting and surprising results.

First of all, nitric acid plays a very little role in the acidification of surface waters since the biological utilization process produces species that neutralize any acid that accompanies the nitrate.

Since most of the unmanaged ecosystem is nitrogen deficient, the nitrate provides some benefit. However, there has been speculation that this process has caused damage by overfertilization of some high elevation forests.

More recent studies suggest other reasons for the observed die back.

Thus, on the evidence today acid deposition due to NO_x is a minimal concern and further regulation of already tight standards is not appropriate. Moreover, our concern about further controlling NO_x is not limited to its minimal role in acid deposition.

Of greater concern is the evidence that any reduction in NO_x will adversely affect the Nation's ability to control ozone, its most pervasive pollution problem.

Virtually all theoretical and experimental studies are consistent in showing that reducing NO_x increases the level of ozone. The experience in controlling ozone in Los Angeles confirms these studies. Thus, great progress was made in the 1960's in Los Angeles in reducing ozone when NO_x was increasing.

But since the advent of NO_x control, we have made essentially no further progress in LA. While this effect on ozone alone should lead us to avoid further NO_x reductions, there are practical technological problems as well.

A principal concern is that the only technology available that would assist us in further reducing NO_x emissions is to add more rhodium to the catalyst. This is simply not possible.

All the available rhodium in the world is already being consumed. Rhodium is a minor byproduct of platinum production and the only commercial sources of rhodium in the world are in South Africa and Russia.

Similarly, the provisions of H.R. 4567 to reduce truck hydrocarbon emissions would also increase rhodium utilization and will also serve to exacerbate this dilemma.

With respect to the provisions in the bill for controlling refueling vapor, such control can only be justified for those reasons that do not comply with the ozone air quality standard.

It simply makes no sense for people in South Dakota, for example, to pay for such pollution control measures that they do not need.

Our calculations show that nationwide control of vehicles for refueling vapors would cost roughly $3,000 for every ton of hydrocarbon removed whereas, selected control at gas stations could be achieved for about $800 per ton.

It is no secret that my industry is in a struggle for survival primarily because of the large cost disadvantage that we suffer at the hands of our Japanese competition. It is clear that many of the provisions in H.R. 4567 will add to that cost disadvantage.

Based on estimates by the utility industry, GM alone will experience an increase in our costs for electricity of at least $75 million annually due to provisions in this bill.

In sum, we have serious concerns about the appropriateness of H.R. 4567 and in our written submission we have made several recommendations for changes in the Clean Air Act that we do believe are urgently needed. The most important has to do with modification of the deadlines in the act for achieving the air quality standards.

The current deadlines are leading to control measures that are not only cost ineffective but that are also counterproductive with respect to air quality. Adherence to the current deadlines will cause significant distortions in economic growth and employment without offsetting environmental benefits.

[Testimony resumes on p. 84.]

[The prepared statement of Dr. Richard L. Klimisch follows:]

Statement of

General Motors Corporation

Mr. Chairman, I am Dr. Richard L. Klimisch, Executive Director of the Environmental Activities Staff of General Motors Corporation. We appreciate this opportunity to present our views on H.R. 4567 -- the "Acid Deposition Control Act of 1986." After reviewing the substantial progress to date in improving air quality, our comments will focus principally on those provisions of the proposed legislation affecting mobile sources and our manufacturing operations.

GM Recommendations With Respect to H.R. 4567

1) Motor vehicles, already severely regulated, should not be further regulated for purposes of acid rain control as vehicles contribute minimally to acid deposition. Additionally, the NOx control provisions in this bill would have unintended and undesirable effects on other aspects of air quality. Finally, the rhodium necessary to meet the additional vehicle controls in H.R. 4567 is simply not available.

2) Nationwide control of refueling vapors is unnecessary. Stage II controls should be required locally only where needed to help achieve compliance with the ambient ozone standard.

3) Industrial boilers, if further regulated, should be allowed monthly average emissions of 1.6 pounds of SO_2 per million BTU, which would permit cost-effective operations using coal containing a maximum one percent sulfur.

4) Further consideration of acid deposition control measures that would amend the Clean Air Act, should also include amendments of the Act which would result in requirements to improve its cost effectiveness. In addition, it it urgent that consideration be given to extending the national ambient air quality standards deadline beyond 1987. Adherence to the current deadline will cause significant distortions in economic growth and employment without offsetting environmental benefits.

General Considerations of Air Quality

At the outset, it is important to recount the progress that has been made in our efforts to improve air quality. This progress can be illustrated by looking at the three pollutants most closely associated with the automobile: carbon monoxide; nitrogen dioxide; and hydrocarbons, a precursor of ozone formation. Most cities can now forecast compliance with the carbon monoxide (CO) air quality standard within the next few years according to the Council on Environmental Quality (CEQ). Overall, monitoring sites in the U.S. are showing steady progress at a rate of about 5% reduction in CO concentration per year and overall CO is down 33% in the last nine years. Moreover, most CO is associated with single monitors located adjacent to the most traffic congested street within the metropolitan area.

The nitrogen dioxide (NO_2)compliance situation is excellent. Contrary to what many think, EPA monitoring data show that NO_2 is not going up and, in fact, every county in this country except one is expected to comply with the NO_2 standard this year. And even that county (Los Angeles) is expected to comply in the next few years.

Even with respect to ozone, CEQ projects most urban areas will comply by the end of the decade, although many of these areas will likely not comply with the present 1987 deadline in the Clean Air Act. Ozone is a secondary pollutant that is formed in the atmosphere through the interaction of several pollutants. Ozone is controlled by controlling hydrocarbons -- one of the precursors of ozone. However, there is a growing recognition in the scientific community that efforts to control ozone have been hampered by the control of NOx.

Turning specifically to the contribution of automotive emission control efforts, compared to uncontrolled cars, automotive emissions have been dramatically reduced by 96 percent for hydrocarbon (HC) and carbon monoxide (CO) emissions and 76 percent for oxides of nitrogen (NOx) emissions. However, these reductions have been increasingly costly, and further reductions (as proposed in H.R. 4567) will come only at very high cost. Moreover, we cannot address further reductions in emissions based on concerns about acid deposition without considering the effects that the proposed measures will have on other aspects of air quality.

Specifically, and as discussed in Attachment A, further NOx control measures may adversely affect ozone levels in urban areas.

Controlling Acid Rain

As a general observation, we note that recent reports by the General Accounting Office, the U.S.-Canadian Special Envoys on Acid Rain and by the National Research Council stop short of recommending specific action at this time to further reduce sulfur dioxide (SO_2) and NOx emissions -- both of which have been identified as contributors to the phenomenon we know as acid rain.

We support the recommendations for further study expressed in the joint U.S.-Canadian report. General Motors looks forward to continuing its active role in the effort to understand better the complex reactions that can occur as pollutants are transported in the atmosphere and subsequently deposited. Unfortunately, too little is known about these events, but programs are underway to obtain the knowledge we need to make prudent public policy decisions.

Nevertheless, considerable progress has already been made in controlling those pollutants usually associated with acid rain. Total national emissions of SO_2 and NOx are well below what they would have been without the controls put in place through the Clean Air Act. In the 1973-1983 decade, SO_2 emissions in the U.S. declined by almost 30 percent, even as electric utility coal consumption increased by about 60 percent. The report also indicates that total NOx emissions have remained fairly constant since 1970, but that NOx emissions from cars and trucks actually dropped by nine percent between 1978 and 1983, despite a five percent increase in the number of miles travelled.

The EPA estimates that total NOx emissions from cars and trucks will decrease an additional 20 percent by the year 2000 (compared to 1982 levels). This significant reduction will occur as the entire fleet of passenger cars is replaced with cars meeting the stringent NOx standard of 1 gpm -- representing the 76 percent reduction referred to earlier -- and as new truck standards already on the books become effective.

Taken together, our current progress and the ongoing efforts to understand the acid deposition phenomena, suggest that there is time to understand the dynamics of acid rain before adopting controls that may ultimately prove to be unwarranted. There is time to do the job right, and in that respect there is much to be said for following the recommendations for further study of acid deposition outlined in the joint U.S.-Canadian Report.

Some Facts About Acid Rain

Acid rain is caused by emissions of SO_2 and NOx which are converted by atmospheric reactions to sulfuric and nitric acids. According to the EPA, sulfuric and nitric acids account for 70 percent and 30 percent of the acidity, respectively, in the most heavily affected areas. Transportation sources emit very little SO_2 compared to other sources, but cars and trucks are responsible for approximately 34 percent of the total NOx emissions. Thus, cars and trucks account for about 10 percent of the acid rain phenomenon (34% of 30% = 10.2%).

The need for acid deposition control has been based on alleged damage to surface waters, forests, materials and human health. Of these issues, surface-water acidification has received the most attention. It is generally accepted that sulfuric acid can cause long-term acidification of surface water. Nitric acid is a minor contributor to this process because of efficient biological utilization in most areas. (In fact, most of the unmanaged ecosystem is nitrogen deficient so the nitrate derived from NOx can provide benefits.) Short-term or episodic acidification can be caused by both sulfuric and nitric acids, although sulfuric acid greatly predominates in most locations.

Forest damage is a more recent issue. Early speculation was that it may be caused, in part, by acid deposition. One hypothesis suggested that very high nitrate deposition due to cloud-water impaction (cloud interception) at high-elevation sites causes a loss of frost hardiness in trees and detrimental changes in soil processes. Later hypotheses speculated on the possible roles of ozone and nitrates. However, many other hypotheses not involving nitrate deposition are also under consideration. The recent NAS study cites climatic factors as the most likely cause of observed forest damage. None of the hypotheses has been proven.

Material damage has not received as much attention as surface-water acidification or forest damage. The greatest damage is due to the dry deposition of SO_2 to various surfaces. NOx and nitric acid deposition do not appear to be as important as SO_2 and sulfuric acid.

Finally, the human health effects issue centers on the dissolution of toxic heavy metals from soil- and water-distribution systems by acidic water. This dissolution is more an SO_2 than a NOx issue, since most surface-water acidification is attributed to sulfuric acid.

Overall, the main environmental issue associated with acid rain appears to be surface water acidification.

Mobile Source Emission Control

According to the EPA, mobile source NOx emissions will continue to decline through the balance of this century. This favorable trend is attributable to the costly control technology needed to meet the very stringent NOx standards already in effect for passenger cars and scheduled to take effect in the near future for trucks.

As discussed, there is no evidence to support more stringent NOx standards for cars and trucks. Therefore, we do not agree that there is a need for the NOx standards proposed in the legislation. In addition, lowering atmospheric NOx levels can cause an increase in the level of ozone. In the scientific community, there is now a consensus that NOx control will do two things to ozone: it will make ozone concentration higher, and it will tend to move the peak ozone back toward the area of highest population. Our scientists, in fact, are convinced that this has happened in Los Angeles -- that the NOx control has in fact offset the HC control programs which is why we have seen very little progress in the last decade. In the previous decade, we made great progress in Los Angeles because HC control was actually accompanied by increased NOx emissions. Our studies show that these effects apply in other areas as well. This phenomenon is discussed further in Attachment A. Because, from a health risk view, NO_2 is of much less concern than ozone, any further NOx reduction for highly uncertain ecosystem benefits must be weighed against the accompanying effect on ozone.

In the 1960s, the air pollution problem and ozone, in particular, were thought to be associated with some serious and debilitating diseases -- lung cancer, emphysema, etc. However, research in the intervening years has alleviated these concerns to a great extent, and for the last ten years or so research on the health effects of ozone and other air pollutants has focused on possible decrements in lung function. These effects not only are reversible but they are so small that there would likely be no clinically significant effects associated with them, at least for ozone levels up to two to three times the standard.

We now know that ozone does not cause eye irritation, but it does cause a number of other problems which are readily observable in southern California. Ozone is associated with and, in fact, is indirectly responsible for a substantial part of the visibility problems in Los Angeles. We also know that ozone can cause damage to some forms of vegetation and, as mentioned above, ozone levels are so high in Los Angeles that some people there undoubtedly do experience respiratory irritation and chest tightness on the worst days. But it is doubtful that such effects occur anywhere else in this country. And, there do not appear to be any long-term adverse effects from such irritation and this reaction -- this small decrement in lung function -- is an involuntary reaction of the body to such irritants. One can draw a parallel with the dilation and contraction of the pupils which is the way the body deals with changes in light intensity. But of most importance, I would point out that there is no evidence that the population of Los Angeles experiences any chronic effects from ozone in spite of the fact the Los Angeles population has been and continues to be exposed to much higher doses of ozone than any other segment of the U.S. population.

Los Angeles, of course, is a special situation, but it is not generally appreciated that ozone levels in that city have been cut in half from what they were in the 1960s and that much of this progress is attributable to what we've done to the automobiles, so that cars now contribute only approximately 30% of HC emissions in Los Angeles, whereas automobiles were thought to be responsible for over 60% in the 1960s. And, of course, that's been accomplished during a period of incredible growth in the Los Angeles area.

With respect to HC emissions for light trucks, there is no apparent need to tighten the standards for purposes of controlling acid rain.

Presumably, the proposed HC standards have been tightened for ozone control. However, the standards, as proposed, do not take into account the current EPA requirement that the truck standards be met for the full life of the vehicle. This would make the truck standards more stringent than the hydrocarbon standard for cars, requirements which cannot be supported on an environmental or technological basis.

Aside from the question of need, there are a number of technical problems associated with each of the proposed HC and NOx standards. They range from insufficient leadtime in most cases, to a lack of suitable technology. A principle technological concern is that today the only practical technology that is available to auto manufacturers for achieving the proposed more stringent NOx and HC levels is to put more rhodium in the catalysts. However, rhodium is an extraordinarily scarce metal -- it is found only as a minor by-product of platinum production. In fact, all the rhodium that currently is being mined is being consumed -- most by the auto industry. We can't recycle yet because we've only been using rhodium for a few years, so that it won't show up in the scrap heap for several years. It should be noted that the only rhodium sources of commercial importance are South Africa, which supplies 75 percent currently, and the Soviet Union. These problems and appropriate recommendations are covered in a detailed discussion paper which is included as Attachment B.

Refueling Vapor Controls

H.R. 4567 would require the control of refueling vapor by using controls either on the vehicle or at the service station pumps (Stage II) or by using both technologies. Requirements for either on-board or Stage II controls nationwide would represent a huge and unnecessary expense for consumers. Requiring both types of controls would seem inappropriate. Requiring on-board controls alone would cost the nation over $400 million annually.

No direct human health risk from exposure to refueling vapors has been established and there is strong evidence to suggest that none will be found. Thus, there is no health-based justification for requiring nationwide control of refueling vapors.

The remaining concern would be for ozone control. Government and industry studies show that the most economical way to address ozone-related concerns is to apply Stage II controls in those local areas which will not be in compliance with the health-based ozone ambient air quality standard by the end of 1987. Regional control of gasoline volatility is another effective way to reduce hydrocarbons and ozone formation.

A cost-benefit analysis of the refueling vapor control alternatives, showing the cost effectiveness of regional control, is included as Attachment C.

Stationary Source Emission Controls

Turning to stationary source controls, GM, like most large manufacturers of durable goods, is a large user of energy. Most of this energy comes from fossil fuel -- generally coal -- which is converted to electricity and purchased from utilities. Fossil fuels also are used in many of our plants to produce steam principally for heating and for use in manufacturing processes, such as steam cleaning parts prior to painting.

The cost of electricity to industrial customers like GM would increase as a result of the legislated reduction of SO_2 and NOx from utility boilers. Nationwide costs of these regulations will probably be discussed by utility representatives. A study prepared for the Edison Electric Institute indicates that GM's electricity costs would increase on average by about $75 million annually during the first five years of full compliance after 1996, when both SO_2 and NOx would be controlled. The total cost to the nation to comply with the lower SO_2 and NOx emissions as proposed, would be in the billions of dollars annually. ($9.2 billion, according to the EEI report; $3.4 to $4.3 billion according to the OTA.)

The proposed legislation also places limits on emissions from industrial boilers after 1996. By that time, the statewide monthly average of SO_2 and NOx emissions from these sources under the bill can be no greater than 1.2 and 0.6 pounds, respectively, per million BTU of heat input.

For states with a high proportion of gas or light oil-fired industrial steam generating capacity, this may prove to be relatively easy to accomplish. However, in many mid-Western states, the proportion of industrial capacity that is coal-fired is high, and the 1.2 pound SO_2

standard is a very aggressive target. To comply using low sulfur coal will require the use of coal containing 0.75 percent sulfur by weight or less. This approaches the lower limit of what is commercially available in quantity today.

If additional control of industrial boilers must be imposed, we believe a statewide monthly average SO_2 emission standard of 1.6 pounds per million BTU, which represents coal having about one percent sulfur by weight, would be a more realistic average to attain in common types of coal-burning industrial boilers. This would avoid forcing many costly conversions to gas or light oil, to wet or dry scrubbing systems, or to totally different technology such as fluidized bed combustion. 1.6 pounds SO_2 is still a tough target to meet in applications where industry produces steam mostly by burning coal.

Clean Air Act Amendments

This concludes our specific comments on the major provisions of H.R. 4567 as they apply to General Motors' products and manufacturing operations. If any emissions-related legislation goes forward, it should also include refinements of the current Clean Air Act to improve its cost-effectiveness. Among such requirements we recommend the following amendments -- none of which would reverse the progress being made to improve the nation's air quality:

- **Modify the December 31, 1987 deadline for compliance with the ambient air quality standards. Some measures being considered** to help meet the current deadline are not cost-effective (i.e., on-board controls for refueling vapor recovery); other measures required by the law (i.e., construction bans, etc.) will impose severe growth penalties on many parts of the country and will be counter-productive with respect to air quality improvement.

- Modify the passenger car standard for carbon monoxide (CO) to 7.0 grams per mile particularly for in-use compliance purposes. Previous submissions by GM have shown widespread support for this modification.

- Provide administrative flexibility to approve alternative procedures, in addition to recalls, to remedy non-compliance situations.

- Provide administrative authority to establish heavy-duty emission levels administratively.

- Reaffirm that the "half-life" concept be applied in determining the "useful life" for all classes of motor vehicles.

A detailed discussion of each of these recommendations is included as Attachment D.

ATTACHMENT A

Statement to the South Coast Air Quality Management District Board Hearing on Oxides of Nitrogen Controls

February 26, 1986

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Introduction

My name is Jon Heuss; I am presently assistant head of the Environmental Science Department at the General Motors Research Laboratories. We have been studying automotive emissions, smog chemistry, and various aspects of control strategy development in our laboratory for over 30 years. I have been involved in that effort for over 20 years. Today, I'd like to briefly review the scientific basis for our knowledge of the complex role of NO_x in smog formation and discuss the implications of that knowledge to your deliberations.

The NO_x Inhibition Effect - Review of the Evidence

In the initial years after Haagen-Smit discovered that it was possible to simulate smog formation in the laboratory, most of our knowledge came from laboratory studies of individual atmospheric reactions and smog chamber experiments. In laboratory after laboratory across the country, similar results were found. In a smog chamber study conducted at GM (Heuss, 1975), we investigated ozone formation in HC-NO_x mixtures simulating Los Angeles. The baseline was a HC-NO_x mixture representative of second-stage alert days in the SCAB in the mid- to late-1960's. Figure 1 shows the maximum O_3 formed from irradiating various HC and NO_x mixtures as a function of the initial NO_x concentration. When hydrocarbons were reduced, substantial reductions in ozone occurred. However, the role of NO_x is much more complex. Initially at low NO_x concentrations, increasing NO_x promotes ozone formation; but at higher NO_x concentrations, ozone actually goes down. This is the so-called NO_x inhibition effect. Note that as we reduce HC, the location of the peak shifts to lower-and-lower NO_x concentrations. This means that the more we reduce HC, the more we will have to reduce NO_x before we get over the maximum and get in a region where NO_x controls help reduce ozone.

Studies conducted in Dr. Pitts' lab at Riverside (Figure 2 -- Finlayson-Pitts and Pitts, 1977) and in the University of North Carolina's outdoor smog chamber (Jeffries, et al., 1977) have shown the same results. We know chemically what causes this strange behavior. We know that ozone is formed in the atmosphere through the reaction of NO_2 with sunlight (photolysis), but that reactions of NO_2 with OH and RO radicals slow down or inhibit ozone formation. We also know that the reaction of NO and O_3 scavenges or removes ozone, but that reactions of NO with HO and RO radicals promote ozone formation. Although there has been universal agreement that NO_x plays this complex dual role of making or promoting ozone formation under some conditions and removing or inhibiting it under others, there has not been universal agreement over how to deal with the phenomenon in the public policy arena. Finlayson-Pitts and Pitts (1977) indicated that the NO_x inhibition phenomenon "is perhaps the curse of control officials".

It is clear that the relationship between emissions and ozone air quality is highly complex and nonlinear -- and that some of the responses to changes in emissions are not only nonlinear, they are opposite to what you might expect from intuition.

Dr. Jack G. Calvert, Chairman of the U.S. National Academy of Sciences Panel on Acid Deposition addressed this issue in his opening statement to the June 1983 Press Conference (1983) accompanying the release of the Academy's 1983 Acid Deposition Report. He said:

> "Nonlinear responses to changes imposed on natural systems are most common. An important example of this is the case of the generation of ozone and other oxidants in polluted urban atmospheres. It is well established that a given percentage reduction in emissions of oxides of nitrogen and hydrocarbons, the most important precursors of urban smog, leads to much less than a proportional reduction in ozone generated in the polluted atmosphere. After many years of research by scientists, theory and experiments have detailed the reasons for the complex nonlinear character of this ozone, nitrogen oxide, hydrocarbon system."

While the presence of these nonlinear effects has been known and accepted for many years, the subject remains controversial, primarily because it has been difficult to turn our knowledge into effective public policy.

Based on the results of our studies in the laboratory, in the field, and with computer models, we have consistently recommended stringent HC control coupled with only moderate NO_x control as a way to reduce ozone as well as NO_2 and avoid as much as possible the NO_x inhibition quandary.

Evidence for the NO_x Inhibition Effect from Computer Models

In order to put smog control policy on a firm scientific basis, we need tools with which to make accurate quantitative predictions. The advent of photochemical dispersion models has finally provided such tools; over the last dozen years or so, such models have been under continued development by government and industry. We agree that care should be taken in interpreting the results of modeling studies, but model calculations are the only way we have of including our detailed knowledge of the complex meteorology and chemistry which is occurring in the various basins of California in the decision-making process. Recent applications of these models have confirmed the importance of the NO_x inhibition effect in urban areas. For example, Chock, Dunker, Kumar and Sloane (1981) applied the ELSTAR trajectory model. The ELSTAR model was developed and tested using the data base provided by the 1973 Los Angeles Reactive Pollutant Program (LARPP). Smog formation was simulated in air parcels (Figure 3) which originated near Los Angeles in the early morning, passed through the San Gabriel Valley, and arrived at or near San Bernardino in the mid- to late-afternoon of days of moderate to high ozone. San Bernardino was chosen because of the concerns raised over the possible effects of changes in NO_x emissions on downwind receptor locations. The model was run on three base-case trajectories from 1973; the results compared favorably with local monitoring data. The model was then run for a number of possible future scenarios. With nonvehicular emissions held fixed at 1973 levels, the reduction in motor vehicle emissions projected by the CARB for present controls resulted in markedly reduced concentrations of both primary pollutants such as CO and NO as well as smog products such as NO_2, O_3, PAN, and HNO_3 along the air parcel trajectories. (An example for the smog products is shown in Figure 4.) However, when HC emissions were held fixed at a projected future level, a further decrease in NO_x emissions (from Scenario A to Scenario B) further decreased NO_2 concentrations, but *increased* ozone and PAN concentrations and did *not* reduce HNO_3 concentrations. For the three trajectories studied, a reduction in NO_x, which decreased peak NO_2 by 29 ppb, *increased* peak ozone by 43 ppb.

The grid model developed at CalTech for the ARB has been applied in a trajectory mode in two cases of which we are aware. One, an early application of the model for a trajectory arriving at Upland on a very smoggy day in 1974, showed that NO_x reduction can increase ozone (Seinfeld and McRae, 1979). The second, a recent application for a trajectory arriving in Riverside on a moderate smog day in 1981, showed that NO_x reductions can decrease ozone (Russell and Cass, 1985).

The grid model developed by Systems Applications, Inc. for EPA has been applied extensively in the South Coast Air Basin in studies sponsored by the National Commission on Air Quality (Souten, Tesche, and Oliver, 1980), the Air Resources Board (ARB, 1981), the South Coast Air Quality Management District (SCAQMD, 1982), and the Western Oil and Gas Association (Roth, Reynolds, Tesche, Gutfreund, and Seigneur, 1983). These studies consistently show that in the western and central portions of the Basin, NO_x reductions tend to cancel the ozone improvement gained from substantially-lowered HC emissions. In the eastern portion of the Basin, the results are mixed and depend on the emission level and boundary conditions. Figure 5, from the 1983 SAI paper, shows the extent of the increases in ozone due to a reduction in all NO_x emissions of 22% from expected 1987 levels. A similar calculation from the 1982 SIP (Figure III-5, SCAQMD, 1982) shows that reducing motor vehicle NO_x will increase ozone over essentially the same area. The SAI paper indicates that each percent reduction in NO_x will decrease 24-hr average NO_2 concentrations by 0.5 to 0.65 percent but increase peak ozone by 0.35% -- again trading NO_2 for O_3.

SAI is also conducting an analysis for EPA of the impact of the light- and heavy-duty truck NO_x regulations recently promulgated by EPA. A paper given by SAI at the June 1985 APCA meeting (Gutfreund, Burton, Oliver, Haney, Hogo, and Seigneur, 1985) indicated, based on a comprehensive modeling study of Philadelphia, that reducing truck NO_x emissions could increase maximum ozone concentrations in the urban area by 4 to 8 ppb, reduce maximum NO_2 levels by 0 to 6 ppb, reduce annual average NO_2 levels by 2 to 4 ppb, and increase rural ozone levels by 2 to 11 ppb -- again trading NO_2 for O_3.

Evidence for the NO_x Inhibition Effect from Field Experiments

There is also direct evidence from experiments conducted in the Basin that the mixture of pollutants found in Los Angeles is in the NO_x inhibition regime. Environmental Research and Technology, Inc. conducted a series of what are called captive air experiments at the University of Southern California in the fall of 1981 (Grosjean, et al., 1982). They filled a series of four Teflon bags with the early morning air on each of 24 days. They added small amounts of either NO or NO_2 to three of the bags on each day. They consistently found that more NO or NO_2 made less ozone compared to the control bag as the bags were irradiated by the natural sunlight throughout the day. The authors of the study concluded that NO_x was inhibiting ozone formation over the range of HC(as ppmC)/NO_x ratios they measured at their site which ranged up to 15.

Los Angeles is not the only location where these phenomena have been studied. Kelly (1985) has shown in an extensive series of captive air irradiations that the Detroit area is also in the NO_x inhibition regime. Importantly, in one set of experiments, the NO_x inhibition effect was shown to carry over to a second day, too. Kelly concluded that a HC control strategy would be more effective in reducing ozone than a combined HC and NO_x control strategy.

Although the NO_x inhibition phenomenon is counterintuitive, each time we have questioned nature about it, in the laboratory, with computer models, or with field experiments -- we have gotten back the same answer. It is a real phenomenon of nature. We still do not have a universally agreed on answer as to where the crossover between NO_x inhibition and NO_x promotion is in the Basin now and how it will change with emission reductions. However, as we have demonstrated, there is a large body of information which indicates that the region where NO_x reductions increase O_3 includes most of the high smog areas of the Basin.

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Evidence for the Effectiveness of Control Strategies from Monitoring Data

Ultimately, the test of emission control strategies is whether they have the intended effects in the atmosphere itself. Fortunately, there has been a strong effort in California over many years to maintain a state-of-the-art monitoring network as well as develop the best available emissions inventories. Unfortunately, there has not been sufficient comparison of the trends in air quality with the trends in emissions in recent years. The only detailed study of long-term trends in both emissions and air quality for the Basin was conducted at CalTech for the years 1965 to 1974 (Trijonis, et al., 1978). There have been recent summaries of air quality trends (South Coast Air Quality Management District, 1985; California Air Resources Board, 1985), but no one has rigorously compared the air quality trends with emission trends, taking into account the spatial variation of growth in the Basin and the variation in meteorology. We strongly recommend that such a study be undertaken; it should include an effort to determine whether existing models can predict the air quality trends that have been observed.

The November draft of the Air Resources Board's Report entitled "The Effects of Oxides of Nitrogen on California Air Quality" (CARB, 1985) does include an analysis of the changes in ozone concentrations due to control of precursor emissions. We reviewed the CARB staff's November draft and provided the Air Resources Board with extensive comments at their December 19, 1985 hearing (General Motors Corporation, 1985). Basically, the CARB staff's draft analysis is not sufficiently rigorous to determine the impact of NO_x or HC controls on ozone formation. That analysis does not take into account spatial differences in emissions growth and reduction, does not allow for year-to-year differences in meteorology, does not address the trend in peak ozone concentrations in the Basin, and incorrectly defines the start of the period during which NO_x concentrations have been declining. In interpreting ozone trends in terms of changes in precursor emissions, it must be recognized that there are at least four important factors changing over time -- hydrocarbon emissions, NO_x emissions, their spatial variation, and meteorology. In order to factor out the influence of any one of these factors, you have to adequately control for the changes in the others. Since the draft CARB staff analysis does not do so, its conclusions regarding the effects of NO_x control are not scientifically supportable.

$\underline{NO_2}$

In order to get a feel for the effectiveness of your current NO_x control program and the need for more NO_x control, one should start with the available NO_x and NO_2 air quality data. NO_x and NO_2 concentrations peaked in the Basin in 1976 and 1977 and have been declining steadily since (CARB, 1985). In Los Angeles County, from 1977 through 1984, for a composite of ten sites, there has been a 32% reduction in both the annual mean NO_2 concentration as well as the annual mean of the daily maximum hour NO_2 concentrations. Over this time period, there has been a 31% reduction in annual mean NO_x concentrations (CARB, 1985). Your NO_x control program has resulted in a dramatic decrease since 1977 in exceedances of the present California NO_2 air quality standard of 0.25 ppm for one hour -- an 88% decrease in the number of days and a 95% reduction in the number of hours during which the state standard is exceeded. In addition, there has been roughly a 40% reduction in the peak one- hour NO_2 concentrations experienced in the basin. In the last couple of years, your state standard has been exceeded only 0.02% of the time in Los Angeles County. As pointed out in the Staff Report for this hearing, you are now very close to the Federal NO_2 air quality standard.

The NO_x emission reduction associated with this dramatic reduction in NO_2 (from 1977 to 1984) is estimated at 21% (CARB, 1985). During the same period (1977-1984), hydrocarbon emissions have been reduced an estimated 36% in the Basin (CARB, 1985).

In discussing the projection of future NO_2 concentrations in relation to attaining and maintaining the Federal and state standards, the Staff Report appears to be of two minds. Projections based on linear rollback calculations assuming all sources contribute equally are presented which indicate that the Federal standard will be attained with the present NO_x control program but that the existing state standard will not. On the other hand, a new modeling study in progress is mentioned which will provide decision-makers with a much more accurate assessment of the contribution of various sources to ambient NO_2 concentrations. Since the results of this study will be available in a few months, and since the state NO_2 air quality standard is being reconsidered by the Air Resources Board (in fact, it is on the agenda for the February 28 CARB hearing), it seems prudent to wait for the CARB's decision and the availability of the improved model before deciding whether additional NO_x control is needed to attain NO_2 air quality standards. It is important to note that the latest CARB projections, which consider the fact that motor vehicle sources are more important than other sources in determining ground level NO_2 concentrations, indicate that the probability of attaining the Federal NO_2 standard by 1987 is 90% and that the existing state standard could be attained at all sites by 1990 with the present NO_x control program (CARB, 1985).

Ozone

The story with ozone, however, is not as optimistic. Although some progress has been made in reducing ozone concentrations in recent years, the progress -- compared to the major reductions in HC and NO_x emissions -- is only modest. The Staff Report points out that the number of days exceeding the Federal ozone standard of 0.12 ppm has decreased 18% from 1976-78 to 1983-85, and the number of days exceeding 0.20 ppm has decreased 22% in the same time period. However, the latest District trends report (SCAQMD, 1985) also shows that a composite of six high ozone sites (Azusa, Pomona, Pasadena, Riverside, San Bernardino, and Fontana) has had only a modest decrease -- a 4.6% decline from 1976 to 1984 -- in the average daily one-hour maximum ozone concentration for the May-October smog period, and a 5% decline over the same time period in the fourth highest daily one-hour maximum ozone concentration (Figure 6). This latter statistic is extremely important because it is the one EPA requires states to use to define their present ozone air quality. When a simple meteorological adjustment was made to the data or when three-year moving averages were applied, the reduction in these ozone statistics over the decade from 1975 to 1984 was still only about 7%. In 1985, although the number of Stage I days (>0.20 ppm) decreased, the number of Stage II days (>0.35 ppm) increased to seven and the highest concentration observed in the Basin (0.39 ppm) was very similar to the peak values in the 1976-1977 time period when ambient NO_x concentrations peaked. So although there has been a marked reduction in NO_x and HC emissions since 1977, and both peak and annual average NO_2 concentrations have declined significantly, peak ozone concentrations are declining much more slowly.

We believe it is important to compare the trends in the post-NO_x control period with those in the pre-NO_x control period. Appendix I of the March draft of the Effects of NO_x on California Air Quality presented the South Coast Air Basin (SCAB) ozone data from 1966 to 1982 in tablular form (Figure 7a) and pointed out the two periods 1966-73 and 1974-82 are roughly considered as times of pre- and post-NO_x emission control. When we added the changes in basinwide HC and NO_x emissions which occurred in these two time periods (Figure 7b), it became evident that more progress was made in the first period when HC was reduced and NO_x was actually increasing than in the last period when both NO_x and HC were being reduced. The analysis of emissions and air quality in the 1965-1974 period was conducted at CalTech (Trijonis, et al., 1978) and has been widely accepted in the technical community. A comparison of the pre- and post-NO_x control periods suggests that the NO_x inhibition effect -- that is reductions of NO_x actually increasing ozone -- is making the control of ozone very difficult, an argument we have been making since the 1960's.

Another important comparison to look at is that between the predictions of your SIP modeling effort and the observed trends. The ozone modeling in the SIP indicated that "The peak ozone concentration of about 0.40 ppm during 1978-80 can be expected to be lowered to 0.29 ppm by 1987 ... with the forecast emission reductions" (Appendix VI-A, SCAQMD, 1982). But the CARB's estimates of the emission reductions you have already accomplished in the 1977-1984 time period are very similar to the changes evaluated in your 1982 SIP for the 1979-1987 time period. It is obviously too early to say what ozone concentrations will be in 1987. But the fact that emission reductions similar to those you projected for 1987 have already occurred and peak ozone concentrations have not dropped commensurately should be a cause for concern.

As you consider additional NO_x controls, you need state-of-the-art estimates of the impact of those controls on ozone, NO_2, PM_{10}, acid deposition, and visibility. The estimates provided in the Staff Report and summarized in Table V-1 are either unquantified, unknown, or calculated with the out-of-date linear rollback method. Fortunately, the District Staff is putting in place improved modeling techniques for the 1987 AQMP. We strongly endorse this effort. NO_x and other pollutants are inter-related in complex ways and only through the use of advanced techniques will you be able to provide an integrated assessment of the multiple effects of pollutants and derive effective control strategies.

Closure

As we have demonstrated, the evidence that NO_x reductions aggravate an already-serious ozone problem in the Basin is substantial. Recent CARB and District reports indicate that your present NO_x emission control program is working well to reduce both peak and annual average NO_2 concentrations. Thus, the contribution of NO_x to PM_{10}, acid deposition, and visibility reduction in the Basin is also being substantially reduced by your present NO_x emission control program. Attainment of the Federal NO_2 standard is imminent, and attainment of the California short-term standard is projected in a few years. Since peak ozone concentrations are going down slowly and since ozone is a more widespread problem in terms of the number of people exposed to concentrations above the standard, the amount of time they are exposed, and the degree to which the peak exposures exceed the standard, we believe that additional NO_x controls should not be imposed until we resolve the controversy over the extent of the NO_x inhibition effect and the Board has a clear understanding of what it takes to make significant progress in reducing ozone. Meanwhile, the present HC emission control program will continue to reduce ozone, PAN, other hydrocarbon-containing smog products, secondary aerosol formation, and will slow down the formation of N-containing products.

Because of the atmospheric coupling of all these pollutants and the nonlinearities involved, state-of-the-art models must be used to determine optimum control strategies. A variety of existing tools and models are available to address the question of an optimum strategy. As we indicated earlier, there is a need for a comprehensive study of emissions and air quality trends in California -- a study which would include the effects of meteorology and the variation in population and industrial growth which has occurred in different parts of your major air basins. A part of this study should include an effort to answer the question -- can the existing models predict the trends that have occurred? There is also a need to continue developing, improving, validating, and applying models as control strategies evolve. As part of that effort, we endorse and will participate in the planned Southern California Air Quality Study.

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FIGURE 1

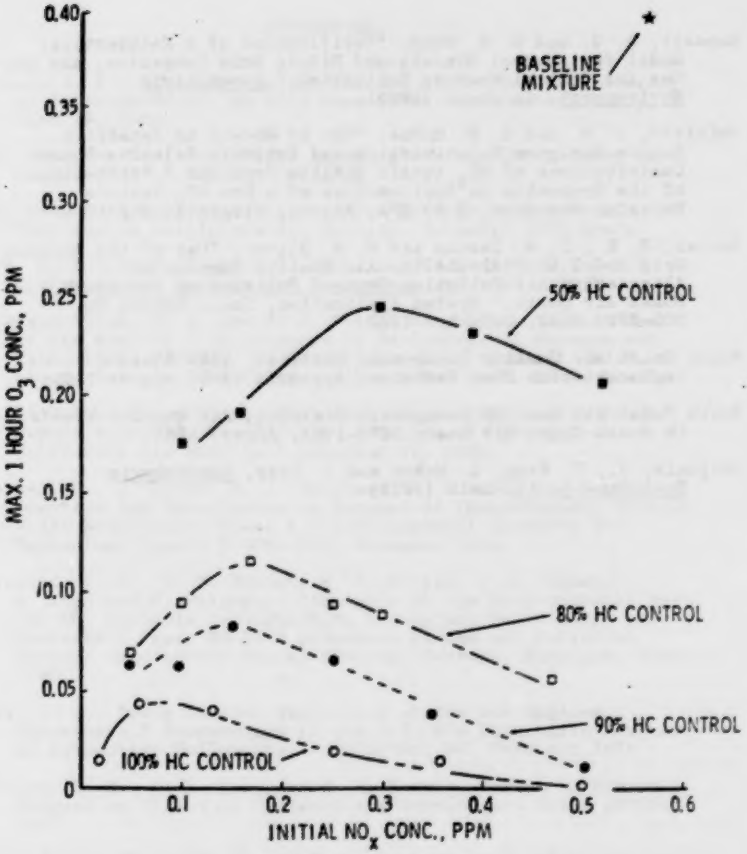
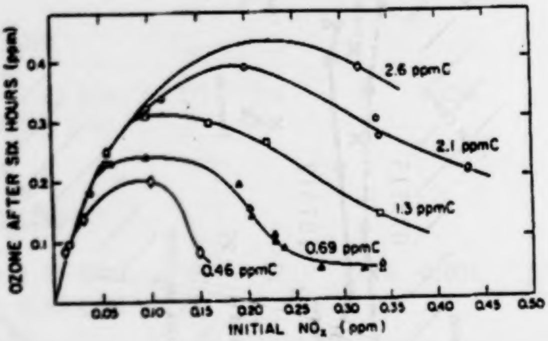

0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0
MAX. 1 HOUR O_3 CONC., PPM
BASELINE MIXTURE
50% HC CONTROL
80% HC CONTROL
90% HC CONTROL
100% HC CONTROL
0.1
0.2
0.3
0.4
0.5
0.6
INITIAL NO_x CONC., PPM

FIGURE 3



Ozone concentration reached after a 6-hour irradiation of NO$_x$ with a surrogate mixture of hydrocarbons simulating ambient air, with varying initial concentrations and ratios of HC/NO$_x$.

FIGURE 3

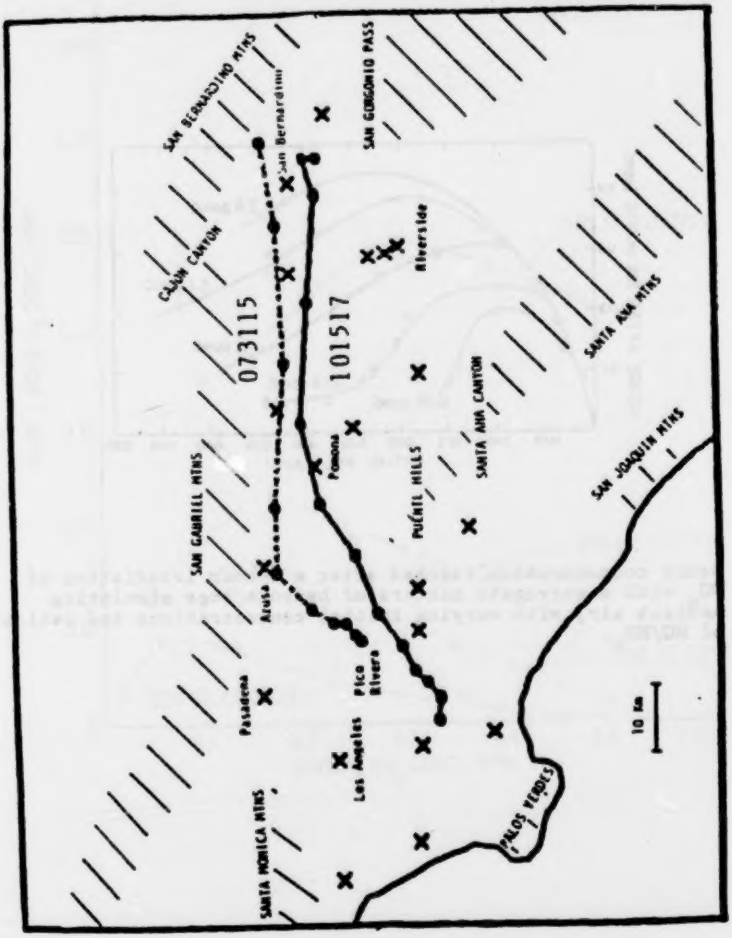
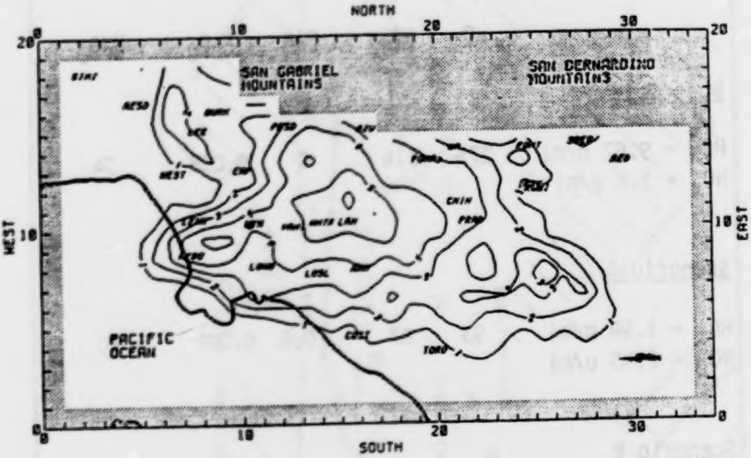

SANTA MONICA MTNS
Pasadena
SAN GABRIEL MTNS
Azusa
CAJON CANYON
SAN BERNARDINO MTNS
073115
San Bernardino
Los Angeles
Pico Rivera
Pomona
101517
SAN GORGONIO PASS
PUENTE HILLS
Riverside
SANTA ANA CANYON
PALOS VERDES
SAN JOAQUIN MTNS
SANTA ANA MTNS
10 km

FIGURE 4

Maximum Concentrations in ppb
for ELSTAR Trajectory 073115

	O_3	NO_2	PAN	H_2O_2	HNO_3
Base Case					
HC = 9.67 g/mi NO_x = 3.8 g/mi	275	114	9	0.058	34
Scenario A					
HC = 1.94 g/mi NO_x = 2.45 g/mi	93	87	0.6	0.001	10
Scenario B					
HC = 1.94 g/mi NO_x = 1.32 g/mi	135	63	1.9	0.004	12

FIGURE 5


NORTH
SOUTH
WEST
EAST
0
10
20
30
SAN GABRIEL MOUNTAINS
SAN BERNARDINO MOUNTAINS
PACIFIC OCEAN
WEST
PASD
AZU
CHIN
LOSL
TORO

Solid lines indicate increases in maximum ozone concentrations in pphm.

FIGURE 8

OZONE IN THE SOUTH COAST AIR BASIN - SUMMARY STATISTICS:
TRENDS IN 6-STATION COMPOSITE AVERAGE, 1975-1984
(Azusa, Pomona, Pasadena, Riverside, San Bernardino, Fontana)

	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
6-Station Mean of Fourth Highest Daily Maximum-Hour Concentration in 3-Years, PPHM	35.3	33.7	34.0	36.5	37.5	38.3	37.5	34.3	32.8	32.0

FIGURE 7a

Area	Percent Ozone Change 3-Year Mean Daily Maximum Hour 1966-1974	 1974-1982
Coastal/Southern	-20	+14
San Fernando Valley/Central	-26	-15
San Gabriel Valley	-23	-17
San Bernardino/Riverside Counties	+21	- 7
South Coast Air Basin	-18	- 8

FIGURE 7b

	Percent Change Pre-NO_x 1966-1974*	 Post-NO_x 1974-1982**
HC Emissions	-18	-35 to 40
NO_x	+36	-15 to 20
O_3 Air Quality	-18	-8

* From Trijonis (1978)

** From CARB March Draft of the Effects of NO_x on California Air Quality

RESEARCH PUBLICATION

GMR-4065
ENV #129

THE EFFECT OF AUTOMOTIVE NO_x EMISSION STANDARDS ON ATTAINMENT OF THE OZONE AIR QUALITY STANDARD

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May 7, 1982

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General Motors Corporat

THE EFFECT OF AUTOMOTIVE NO_x EMISSION STANDARDS ON ATTAINMENT OF THE OZONE AIR QUALITY STANDARD

CONCLUSIONS

The ozone air quality standard is exceeded in 14% of the 3,212 U.S. counties -- the most densely populated ones. Reducing nitrogen oxide emissions below those already achieved throughout the U.S. will frustrate the efforts to attain the ozone standard. Both theory and experiment have long since established that ozone is reduced by control of hydrocarbon emissions, and many of those studies have also indicated that concurrent reductions in NO_x emissions could increase ozone levels. However, newly developed computer models have only recently confirmed the negative effect of NO_x control on ozone, which laboratory smog chamber studies have consistently shown. Thus, the result of reducing NO_x emissions will be that ozone concentrations above the air quality standard will persist for a number of years beyond that which is actually necessary. Furthermore, cities with the highest ozone levels may find it impossible, to achieve the ozone air quality standard with the 1.0 g/mi NOx standard. On the other hand, increasing the motor vehicle NOx standard from 1.0 to 2.0 g/mi will reduce future ozone concentrations by 0.01 to 0.05 ppm, and the greatest reductions will occur in the cities with the most severe smog problems.

DISCUSSION

Nitrogen oxides (NO_x) emissions are involved in two related environmental concerns -- nitrogen dioxide air quality and ozone air quality. Available data show that all areas of the nation outside California have NO_2 air quality equal to or better than the National Ambient Air Quality Standard (NAAQS). Under Federal law, California has its own unique motor vehicle emission control program separate from the rest of the nation. A Federal car NO_x standard of 2.0 g/mi should result in improvement in the already satisfactory situation in the other 49 states as new cars replace older, higher emitting cars.

In contrast, the ozone air quality standard is exceeded in 14% of the nation's 3,212 counties. A number of computerized photochemical dispersion models recently have been used to predict the impact of changes in oxides of nitrogen emissions on ozone levels (the official indicator of photochemical smog) which occur both in and downwind of major cities. Only one of these studies has explicitly addressed the sensitivity of future ozone concentrations to the automotive NO_x emission standard. This is the study by Chock et al[1] which will be discussed below. A number of studies, however, have investigated the effect of changes in the total NO_x emissions from all sources.

The results of all these studies support the conclusion that increasing the NO_x emission standard from 1.0 to 2.0 g/mi will reduce future ozone concentrations by between 0.01 and 0.05 parts per million (ppm) in many cities -- with the greatest reductions occurring in the cities which have the worst ozone problems. The magnitude of this reduction is a significant fraction of the national ambient air quality standard (NAAQS) for ozone, i.e. 0.12 ppm for one-hour not to be exceeded on more than one day per year. For the most polluted cities outside of California, the ozone air quality, on the worst smog days, in recent years has ranged from 0.20 to 0.30 ppm, and up to 0.45 ppm in Los Angeles.

As new cars with stringent hydrocarbon (HC) controls replace older cars, motor vehicle HC emissions will decrease steadily. This, coupled with reductions in HC emissions from other sources will reduce ozone concentrations in our major cities. However, if the automobile NOx emission standard is left at 1.0 g/mi, a significant fraction of the potential benefit from the HC emission reduction will be lost.

A study by Chock, Dunker, Kumar, and Sloane[1] of the General Motors Research Laboratories directly examines the effect of motor vehicle NOx emissions on ozone. Chock et al. applied a sophisticated trajectory model to California's South Coast Air Basin. The model was first validated by simulating the situation which occured on specific days of moderate to high smog intensity in 1973. The model predicted atmospheric concentrations close to those measured by air quality monitors throughout the basin. The model responded as expected when motor vehicle emission standards were reduced to 0.41 g/mi hydrocarbons, 7.0 g/mi carbon monoxide, and 1 g/mi of oxides of nitrogen; namely, the predicted atmospheric concentrations of carbon monoxide, oxides of nitrogen, ozone, peroxyacetyl nitrate and nitric acid were markedly reduced along the air parcel trajectories. Additional projections were made by changing only the emission rate of oxides of nitrogen in the latter scenario. These calculations showed that an increase of about 1 g/mi in average vehicle NO_x emissions reduced ozone by between 0.04 and 0.05 ppm.

This 1 g/mi difference in motor vehicle NO_x emissions is equivalent to a 20% change in the total current NO_x emissions in the Los Angeles basin. This equivalence is useful in interpreting the results of studies which did not explicitly look at changes in motor vehicle NO_x emissions. For studies that only varied total NO_x emissions, this equivalence will be assumed to hold.

An early application of a photochemical dispersion model developed at the California Institute of Technology for the California Air Resources Board includes a calculation showing that a reduction in motor vehicle NO_x equivalent to 5% of the total NOx emissions in the South Coast Air Basin will increase ozone by 0.01 ppm[2]. This is consistent with the Chock conclusion, since an emission reduction of one fourth as much produced a proportionately smaller increase in ozone level.

Systems Applications Inc. (SAI), has been developing a large grid model for the U.S. E.P.A. Applications of its model have been sponsored by both the U.S. National Commission on Air Quality[3] (NCAQ) and the California Air Resources Board[4] (CARB). These studies also show that NO_x reductions tend to cancel the ozone improvements gained from substantially lowered HC emissions[5].

Under CARB sponsorship SAI calculated the effects of changing HC and NO_x emissions independently. In one set of calculations simulating a two-day smog episode, the effect of a 75% reduction in all HC emissions was compared at either zero, 25% or 50% reduction in NO_x emissions. A 75% HC reduction, in combination with present NO_x levels, predicted 40% reduced ozone concentrations, from 0.336 ppm down to 0.203 ppm averaged over 5 sites spread throughout the smoggiest part of the South Coast Air Basin. However, when a 25% NO_x reduction was added to the 75% HC reduction, the ozone increased from 0.203 ppm to 0.230 ppm. Additional NO_x reduction, to 50%, diminished the benefit further, increasing ozone to 0.241 ppm. Thus, a combination of NO_x control and HC control markedly increased ozone compared to controlling HC alone – again pointing out that stringent NOx control is counterproductive.

Los Angeles is not the only location in which the effects of NOx have been studied. Duewer et al.[6] have applied the LIRAQ model, developed at the Lawrence Livermore Laboratory of the University of California, to a particular day in St. Louis, Missouri. With a base ozone air quality of 0.19 ppm, a 40% reduction in HC emissions reduced the ozone to 0.08 ppm. However, when a 20% reduction in NOx was added, the resulting ozone was 0.11 ppm. This ozone increase of 0.03 ppm for a 20% NOx reduction is similar to that observed with the other models as noted above.

Derwent and Hov[7] have applied a model to the city of London and projected the impact of various motor vehicle emission standards under consideration in Europe. Although the various combinations of HC and NOx do not allow a direct comparison with Los Angeles or St. Louis, they again consistently found that NO_x reductions increase ozone and erode the gains made by HC reductions.

The results of those modeling studies for which the ozone increase can be quantified on a comparable basis are summarized in Table I. The ozone increase for a 20-25% reduction in NO_x falls between 0.03 and 0.05 ppm for all of these studies.

TABLE I

SUMMARY OF NO_x EFFECT ON OZONE LEVEL

Reduction in NO_x	Increase in Ozone	Reference
5%	0.01 ppm	2
20%	0.04-0.05	1
20%	0.03	6
25%	0.027	4

Similar projections are found using EPA's EKMA model[8]. EKMA is a simplified modeling approach compared to those described above and thus has the virtue of requiring less input information. Predictions made using the EKMA model are of particular interest because this is the model which almost all states will be using for their 1982 State Implementation Plans. To use EKMA, one must specify the present air quality and the ratio between the concentrations of HC and NO_x (HC/NO_x) in the atmosphere appropriate to the specific location. We have investigated EKMA predictions for a range of initial values of ozone air quality and for various HC/NO_x ratios typical of those that will be used by the various states which have ozone problems. This investigation includes a range of HC/NO_x ratios from 4 to 7.5, and ozone values of 0.20, 0.28, and 0.36 ppm, which encompass the values found in the most polluted U.S. metropolitan areas.

As shown in the second column of Table II, we applied EKMA to find the degree of HC emission reduction required to achieve the 0.12 ppm ozone NAAQS with present atmospheric NO_x levels. Then we determined the impact of a 20% reduction in NO_x emissions at the reduced HC level, as shown in the third column of Table II. We found that in each case, the 20% NO_x reduction increased ozone above the air quality standard, sometimes by as much as 42%. As shown in the table, the greatest increases in ozone from NO_x control occurred in those situations where present ozone levels are the highest. We anticipate the NO_x inhibition effects may be even larger than the estimates in Table II because Trijonis[9] has shown that EKMA tends to understate the role of NO_x as an ozone inhibitor.

TABLE II
EXCEEDANCES OF OZONE AIR QUALITY STANDARD CAUSED BY NOx REDUCTION

Current Max. Ozone (PPM)	HC Reduction Required to achieve Ozone Standard (as % of total HC Emissions)*	Exceedance of Ozone Standard caused by a 20% NOx reduction (as % of the Standard)*
0.36	45% - 60%	30% - 42%
0.28	42% - 60%	25% - 42%
0.20	28% - 55%	16% - 25%

*The range of values reflects a variation in the HC/NO_x ratio for various cities of 4 to 7.5.

The exceedances of column 3 were calculated at the reduced HC levels of column 2.

Thus, EKMA, as well as the more sophisticated models, predicts that NO_x reductions will erode the gains made by HC control. This means that retention of a 1.0 g/mi automobile NO_x standard makes achievement of the ozone NAAQS considerably more difficult. Indeed, any city which achieves a 60% HC reduction and still is 20%-40% over the ozone NAAQS will find it extremely difficult to achieve the ozone standard, since further reductions in HC to offset the deleterious NO_x impact may be unattainable.

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GMR-4255
ENV #145

The Role of Nitrogen Oxides in Smog and Acid Rain

by

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for publication in
The Environmental Forum

January 31, 1983

Nitrogen oxides (NO_x) emissions are involved in a number of related environmental concerns. These include nitrogen dioxide air quality, the formation of ozone and other photochemical smog products, and the acid rain phenomenon. This article will summarize the current state of knowledge of the various roles of NO_x emissions and discuss the policy implications of this information. Of necessity, we will have to consider the various chemical reactions which NO_x emissions undergo after they are emitted into the atmosphere.

Let's start with a definition of NO_x itself. When fossil fuels are burned, nitric oxide (NO) together with smaller amounts of nitrogen dioxide (NO_2) are produced. The combination of the two is referred to as NO_x. The major emission, nitric oxide, is relatively innocuous, but undergoes various transformations in the presence of hydrocarbons (compounds containing carbon and hydrogen which occur in petroleum and other fossil fuels) to produce more irritating and oxidizing substances, including ozone (O_3), nitrogen dioxide, and other chemical species such as peroxyacetylnitrate (CH_3COONO_2). The mix of products is a form of air pollution referred to as photochemical smog. Of these products, ozone is of the most concern from a health standpoint.

Smog Chemistry

For smog to form, nitrogen oxides, hydrocarbons, and sunlight must be present. The involvement of NO_x and sunlight centers on reactions 1 and 2 in which an oxygen atom is transferred from nitrogen dioxide to oxygen, producing nitric oxide and ozone.

$$NO_2 + \text{sunlight} \rightarrow NO + O \qquad (1)$$

$$O + O_2 \rightarrow O_3 \qquad (2)$$

Sunlight is required to break the oxygen atom away from the nitrogen dioxide. In the absence of hydrocarbons, the ozone produced in reaction 2 reacts rapidly with the nitric oxide produced in reaction 1 to regenerate the starting materials and there is not net change.

$$NO + O_3 \rightarrow NO_2 + O_2 \qquad (3)$$

Reaction 3 is just the reverse of reactions 1 and 2. Chemists call this situation an equilibrium. Small amounts of these species will always exist in the atmosphere, but the amount of ozone present from this equilibrium is small and well below the level of concern.

When hydrocarbon molecules are present, however, the situation changes. Hydrocarbons provide a second route for oxidizing NO to NO_2. As the hydrocarbons themselves are oxidized in the atmosphere, small oxidized fragments (called free radicals) react with NO via reaction 4 to make NO_2.

$$RO_2 + NO \rightarrow NO_2 + RO \qquad (4)$$

where R = H or a hydrocarbon fragment

Since reaction 4 removes NO, it short circuits the equilibrium by blocking reaction 3. Thus, the ozone formed in reaction 2 can now accumulate in the atmosphere. This makes it easy to see why the amount of ozone that forms depends, primarily, on the amount of hydrocarbon present. In addition to forming NO_2, reaction 4 produces another free radical which is also highly reactive and enters into other reactions which eventually regenerate another RO_2 radical. A sequence of such steps is called a chain reaction. The chain might go on endlessly except that radicals also react with NO_2 as in reaction 5 to form stable products.

$$RO + NO_2 \rightarrow RONO_2 \qquad (5)$$

This, in effect, stops smog formation, terminating the chain and removing NO_2 so it can no longer photolyze and make ozone in reactions 1 and 2. If the RO in reaction 5 is an OH radical, the product is HNO_3, nitric acid. Thus, the oxides of nitrogen can both promote smog formation (reactions 1, 2 and 4) and inhibit smog formation (reactions 3 and 5).

Whether oxides of nitrogen are inhibiting or not in a given situation depends primarily on the relative amounts of hydrocarbons and NO_x (the hydrocarbon/NO_x ratio) rather than the absolute amount of smog reactants. This occurs because there are competing reaction paths for many of the radicals and molecules in the smog process so that the ratio of reactants determines which reaction path predominates.

We have summarized the most important NO_x reactions in smog chemistry. Naturally, a complete description requires many more chemical species and reaction paths. The latest mathematical models of smog compute upwards of 60 reaction paths and typically incorporate 40 chemical species to account for the chemical transformations in smog formation. So, although it takes hydrocarbons, oxides of nitrogen, and sunlight to form smog, smog can't be considered as a simple linear reaction between hydrocarbons and NO_x. That is, reductions of either of the precursors will not necessarily lead to reductions in smog formation.

Scientists have been unraveling the chemistry of smog ever since the phenomenon was first discovered in Los Angeles shortly after World War II. The early work -- which involved irradiating dilute mixtures of hydrocarbons and oxides of nitrogen in smog chambers -- demonstrated that hydrocarbon reduction would reduce smog. Even though we didn't have a complete understanding at the time, these experiments were the basis for the first California and Federal emission standards for hydrocarbons. Such experiments conducted in laboratories all across the country have also shown that NO_x reductions can increase the formation of ozone and other smog products in urban areas.

Although the complex and paradoxical role of NO_x has been known to scientists and control officials for many years, this information has not, as we will discuss later, been translated into effective public policy. It has been the subject of controversy for many years. One of the unanswered questions has been how far downwind does the NO_x inhibition effect persist. In recent years, the advent of mathematical models of smog has finally provided the decision maker with a tool to answer such questions. The initial applications of smog models are affirming the predictions from smog chamber studies that NO_x reduction in urban areas will increase ozone concentrations. These model applications have demonstrated that the NO_x inhibition effect persists throughout the first day's transport downwind of an urban area and based on multi-day simulations of Los Angeles carries over to subsequent days. The search for an optimum smog control strategy is continuing, but the message which comes out of the modeling studies is that maximum control of various NO_x and hydrocarbon sources is not the optimum control strategy. The policy implications of these findings will be discussed later.

Acid Rain

The phenomenon of acid rain or acid deposition is even more complex than smog and we know less about it. However, the fact that we don't understand all the details of acid deposition is not an excuse to defer making public policy in this area. Rather it is a caution that public policy and regulatory action should be based on our best scientific understanding and should be flexible enough to adjust to new information as it arises.

Most of the attention concerning the acidity of precipitation falling on the northeastern U.S., Canada, and northern Europe has been directed at sulfur dioxide (SO_2) emissions. The dominant strong acid anions in precipitation are sulfate and nitrate, therefore, emissions of both sulfur dioxide and nitrogen oxides are implicated. The deposition of acids is of concern because of possible adverse effects on sensitive lakes, streams, soils, and forests. In addition to the deposition of acids in rain and snow (referred to as wet deposition), acidic gases and particles in the air are deposited on various surfaces by adsorption, absorption, and gravitational settling. These mechanisms are referred to collectively as dry deposition.

The acid deposition phenomenon is more complex than the smog phenomenon because it involves complex chemical transformations in both the gas phase, the liquid phase, and on surfaces; transport over long time and distance scales; and interactions with and effects on terrestrial and aquatic ecosystems, agriculture, and man-made structures. NO_x emissions can contribute to acid deposition both directly as a source of nitric acid and indirectly as they influence the oxidants which convert sulfur dioxide to sulfuric acid. Both these contributions will be discussed in turn.

Direct Involvement of NO_x in Acid Deposition

On average, it is generally accepted that seventy percent of the acidity of precipitation in the eastern U.S. is associated with sulfuric acid and thirty percent with nitric acid. Since acid deposition is a regional phenomenon, we can get a first approximation of the contribution of various emission sources to the acidity by combining the available emission inventories for SO_2 and NO_x in the eastern U.S. with the 70/30 split. On this basis, utilities are responsible for 51% of the acidity, other stationary sources 35%, and all mobile sources 14%. The mobile sources break down to 5% from autos, 5% from trucks, and 4% from other transportation sources such as planes, trains, and off-highway vehicles. We do not have reliable measurements of dry deposition, so it is difficult to do a similar calculation for total acid deposition.

It is also important to consider the acidifying effects that the deposited species have on the ecosystem in examining the importance of various sources. For sulfur, the three major deposited species, i.e., sulfur dioxide, ammonium sulfate ($(NH_4)_2SO_4$), and sulfuric acid (H_2SO_4), are all expected to cause acidification of aquatic and terrestrial ecosystems. In contrast, most of the nitrate (NO_3^-) deposited does not cause similar acidification due to its rapid biological utilization. The biological utilization of nitrate by plants leads to the production of a hydroxyl ion (OH^-) which is released to the soil where it can neutralize a hydrogen ion (H^+). Thus, there is little net acidification from HNO_3 deposition.

The magnitude of nitrate utilization can be determined by monitoring the total input and output of nitrate in an ecosystem. The experimental results in small calibrated watersheds show a dramatic difference between nitrate and sulfate. Only a small fraction, less than 25%, of the wet and dry deposited nitrate is removed from the watershed by the output stream, whereas most of the wet and dry deposited sulfate passes through the watershed. Thus, it is clear that most of the nitrate is utilized in the ecosystem. The only time during which HNO_3 may be a major acidifying species is during the spring snowmelt period when nitrate stored over the winter is released in a short period of time. At this time the ground may still be frozen and biological activity may be at a minimum. However, recent studies have shown that sulfate is still the major acidifying species in the spring runoff in most locations.

Indirect Roles of NO_x in Acid Deposition

One of the major unknowns related to acid deposition is the nature of the process whereby sulfur dioxide is converted to sulfuric acid. There is evidence from laboratory studies that the oxidation can occur in the gas phase, in droplets, and on surfaces. In contrast, it is generally accepted that the primary formation route for nitric acid is reaction 5. In the gas phase, the predominant SO_2 oxidation process is reaction with hydroxyl radicals.

$$OH + SO_2 \rightarrow \rightarrow \rightarrow H_2SO_4 \qquad (6)$$

Although this initial step is well accepted, the details of how the $HOSO_3$ adduct further reacts and rearranges to form sulfuric acid droplets are not known. Since OH reacts with NO_2 about ten times faster than with SO_2, one would predict that nitric acid formation occurs closer to the source than sulfuric acid formation. Ambient measurements and modeling have confirmed this phenomenon. The competition between SO_2 and NO_2 for OH radicals is another example where the ratio of reactants is important. In this system, decreasing NO_2 will increase the rate of sulfuric acid formation.

There is also evidence that SO_2 is being oxidized in cloud droplets. While a variety of oxidizing species may be involved, it has been proposed that hydrogen peroxide (H_2O_2) may be the most important. There is also evidence that soot or various metals can catalyze the oxidation of SO_2 to H_2SO_4. It has even been suggested that the oxides of nitrogen may catalyze SO_2 oxidation. Our knowledge of these processes is limited so it is difficult to predict the impact of NO_x changes on the liquid phase oxidation of SO_2.

However, we do know that the various potential oxidizing species, OH, HO_2, O_3, and H_2O_2 are influenced by both hydrocarbons and NO_x emissions through the smog chemistry summarized earlier. We expect that reductions in hydrocarbon emissions will reduce the atmospheric concentrations of these oxidizing substances. There are small concentrations of each of these species present naturally in the atmosphere, so complete elimination of man-made hydrocarbon emissions will not eliminate atmospheric oxidation of SO_2. The effect of NO_x changes on these oxidizing species should be similar to the effect on ozone. Thus, it is quite possible that reductions in NO_x emissions from present levels will increase the rate of sulfuric acid formation and thus aggravate the acid rain problem.

Unfortunately, the present models of long-range transport and deposition do not yet include the complex, coupled chemistry of HC-NO_x-SO_2. Simplified versions of the coupled chemistry, however, are now being tested and give predictions which are in qualitative agreement with the preceding discussion. That is, reductions in hydrocarbon can reduce sulfuric acid formation but reductions in NO_x can actually increase sulfuric acid formation.

Policy Implications

The course of action chosen in 1959 in California and in the 1960's at the Federal level to control auto exhaust hydrocarbon emissions to reduce smog have proven to be justified. In the case of NO_x, however, the situation is different. The U. S. Congress, in 1970, passed the first Federal auto NO_x emission standard. It required that a 90% reduction from the emission levels of 1971 model year vehicles be achieved by the 1976 model year. Although it is not clear from the legislative history what the basis for that decision really was, it is clear that the role of NO_x in inhibiting ozone formation was not a consideration in the Congressional deliberations. The 1970 decision which was presumably based on the need to reduce ambient NO_2 concentrations was made before the Federal NO_2 air quality standard was set. It turns out that the U.S. (except for California which has its own emission standards) is essentially in compliance with the present Federal NO_2 air quality standard.

Since 1970, the Congressional debates regarding automotive NO_x standards have primarily been over the technical feasibility of meeting various stringent emission standards, and to some extent the need based on NO_2 air quality considerations. Unfortunately, the liklihood that stringent NO_x control will aggravate the nation's ozone air quality problem is not a major consideration on Capital Hill. There are a number of reasons why this important chemical phenomenon is not being given enough consideration. It is complex. It is counterintuitive. And, you need a sophisticated experimental or mathematical model to apply the information to develop control strategies. Until recent years, such models have not been available. However, both the EPA developed model which the States used in the development of their 1982 State Implementation Plans and at least five other available models include the appropriate chemistry. The initial applications of all these models predict that a 20% reduction in NO_x emissions, for example, will increase ozone from 0.01 to 0.05 ppm in various cities -- with the greatest increases occuring in the cities with the worst ozone air quality. For comparison, the ozone air quality standard is 0.12 ppm (not to be exceeded on more than one day a year) and the worst polluted cities outside California exceed the standard by about a factor of two. So, the interactions between NO_x and ozone must be considered in the development of smog control strategies. If not, much of the billions of dollars we are spending each year on control technology will be wasted.

The acid rain phenomenon, although intimately connected with the smog phenomenon, is less well understood at present. We have not yet agreed on just what it is we want to reduce -- the pH of rain, the overall deposition of sulfur, or something else -- and we don't know how much we have to reduce it to minimize the effects. For smog, we have air quality standards for ozone and nitrogen dioxide to meet which are protective of public health and welfare. In acid rain, we are just beginning to define analogous goals to protect aquatic and terrestrial ecosystems, crops, and materials. In addition, we are years away from having quantitative models of transport, transformation, and deposition to aid us in achieving those goals. This is not an excuse to defer action, rather it is a reason to proceed carefully with the recognition that we will need to factor in new information as it becomes available.

In discussing various policy options, it is important to distinguish between SO_2 and NO_x emissions. While both are sources of acidity in precipitation, the effects of sulfuric and nitric acid on ecosystems are different. The two precursors have different solubilities, they undergo different chemical reactions in the atmosphere, and the volatilities of their strong acids are different.

If a major SO_2 reduction program is undertaken, it will be important to recognize that our nation's hydrocarbon and NO_x control policies have a major impact on SO_2 oxidation. While any SO_2 reduction will result in a proportional reduction in the deposition of total sulfur aggregated over the downwind area, the deposition of particular chemical forms of sulfur (i.e. sulfuric acid) may not be proportionally reduced and the deposition in specific sensitive areas also may not be proportionally reduced. Our nation's hydrocarbon control program should slow down the oxidation of SO_2, but the concurrent NO_x reductions may well increase the rate of SO_2 oxidation.

In both the smog and acid rain phenomena, we are dealing with highly coupled non-linear chemical systems. Since we are spending billions of dollars a year on emission controls and contemplating a major increase in that effort for SO_2 reduction, it behooves us to use our knowledge of these systems to try and optimize the control strategies. Based on information at hand, NO_x reductions, in particular, may backfire on us and aggravate both the smog and acid rain problems. Policy makers who ignore the complex chemistry involved do so at both their and our peril, because nature does not ignore these complexities.

Attachment B

The following concerns proposed amendments to the Clean Air Act for mobile source emissions under Title II, Sec. 201 in Rep. Sikorski's bill, H.R. 4567. These amendments, listed below, would require stringent emission compliance levels and insufficient leadtime schedules; GM's response to each is also included.

- Amendment: Beginning MY 1989 and after, NOx emissions standard for passenger cars shall not exceed 0.7 gpm.

  Response: Cars are already meeting a rigorous 1 gpm NOx standard.

  Controlling NOx to an even higher standard could exacerbate the ozone problem by moving the peak ozone back to the area of highest population. Refer to Attachment A for a more detailed discussion.

  Additional rhodium for the catalyst would be needed -- a scarce resource whose limited availability is confined to South Africa and the Soviet Union.

  Under the 0.7 gpm NOx, only 300,000 tons of NOx emissions per year by 1997 would be reduced, which is only a 1% reduction in nationwide NOx emissions. In addition, this would account for only a 0.3% reduction in acid rain precursers making any environmental benefit minimal.

  Adjusting the calibration of an engine to lower NOx emissions can produce higher HC and CO emissions, thus increasing the risk of recalls for CO and HC noncompliance.

- Amendment: Beginning MY 1988 and after, NOx emissions standard for gasoline trucks weighing up to 8,500 lbs. shall not exceed 1.2 gpm; and, beginning MY 1988 and after, NOx emissions standard for gasoline trucks weighing from 8,500 to 14,000 lbs. shall not exceed 1.7 g/Bhp-hr.

  Response: Industry negotiated with EPA to define vehicle weight by "loaded vehicle weight" (LVW) rather than "gross vehicle weight" (GVW) as this definition is more accurate and is less susceptible to classification jumping. A LVW of 3,750 lbs. differentiates the full-size truck from a compact truck, and should be utilized rather than a 6,000 lb. GVW as proposed in H.R. 4567.

  EPA just set a challenging 1.7 gpm NOx standard for the full-size truck. With the 120,000-mile "useful life" and the greater load carrying capacity, the 1.7 gpm standard is considered the absolute lowest achievable for this weight class.

GM estimates a fuel economy penalty of about 1 - 2% should tighter NOx control be mandated.

Due to the noncompliance of HC and CO standards for trucks weighing 8,500 - 14,000 lbs., GM intends to utilize the EPA option of certifying those vehicles up to 10,000 lbs. classification to the current light-duty truck 1.7 gpm NOx standard. A 1.2 gpm standard would effectively eliminate this option and could eliminate production of all gasoline-powered trucks in the 8,500 - 14,000 weight category.

- **Amendment:** Beginning MY 1988 and after, NOx emissions standard for diesel trucks weighing up to 6,000 lbs. shall not exceed 1.2 gpm; and, beginning MY 1988 and after, NOx emissions standard for diesel trucks weighing from 6,000 - 8,500 lbs. shall not exceed 1.7 gpm.

  Response: As discussed previously, the 3,750 lb. LVW breakpoint should be utilized to categorize light-duty trucks, rather than the 6,000 GVW. (Otherwise, the provisions of the bill simply codify existing EPA NOx regulations.)

- **Amendment:** Beginning MY 1990 and after, HC emissions standard for trucks weighing up to 6,000 lbs. shall not exceed 0.41 gpm; and, beginning MY 1990 and after, HC emissions standard for trucks weighing 6,000 - 8,500 lbs. shall not exceed 0.53 gpm.

  Response: Due to the stringency of this proposed standard, (which in fact is more stringent than the current HC standard for passenger cars) catalysts would have to be replaced at 60,000 miles at an estimated annual average cost to the purchaser in excess of $350 million.

  The converter change would effectively double strategic noble metal usage in light-duty trucks.

  GM estimates the control measures necessary to control HC at the proposed HC level would impose a fuel economy penalty of about 7 - 8%.

  The proposed standards do not recognize the impact of the current requirement that these standards be met for the "useful" life of 120,000 miles. The higher load factor and added catalyst thermal degradation which results from higher exhaust temperatures impose a very severe environment, which can lead to catalyst failure.

ATTACHMENT C

Controlling Vehicle Refueling Vapors

A Cost-Benefit Analysis

November 6, 1985

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Attachment D: Graph Chart Depicting Four EPA Strategies

Attachment E: Refueling Vapors, Evap Emissions, Volatility

Attachment F: Cost-Effectiveness of Four EPA Strategies

This cost-benefit analysis of controlling refueling vapors is based on the July 1984 EPA strategies document on gasoline marketing. However, because the document differs in many instances from our analysis, we have included certain changes that should be considered. Those changes are identified in this analysis.

The conclusions reached in our analysis indicate that onboard refueling vapor controls cannot be justified for reducing air pollution. The costs of such a program would substantially outweigh the societal benefits. It may be cost-beneficial to reduce air pollution with Stage II controls (gas pump modifications) but only in certain geographic areas that are experiencing difficulty in meeting the national ambient air quality standard for ozone -- so-called non-attainment areas.

Refueling vapor controls of any variety cannot be justified on the basis of direct health benefits. The only known potential health risk from gasoline refueling vapors is the risk of cancer due to benzene exposure. That risk, less than one cancer per 40 million lifetimes, is well below the level EPA's Carcinogen Assessment Group deems "negligible." A discussion of the health issue is included in Attachment A.

The refueling vapor control issue comes down to what set of controls can maximize the net societal benefits (societal benefits less societal costs) of reducing refueling vapors for the nation. This issue embraces areas which have attained the Federal ozone air quality standard as well as those which have not.

It is not possible to assign an exact dollar benefit to reduced air pollution, even where no appreciable health benefits are at stake, as in the present case. However, an upper bound on the benefits of controlling pollution from volatile organic compounds (VOC) can be measured by the maximum reasonable costs that society is now incurring for control in both non-attainment and attainment areas. (This assumes that actions up to now are cost-beneficial at the margin.)

In the non-attainment areas a variety of measures are being taken to control stationary and non-stationary VOC pollution sources for up to approximately $1500 per metric ton (hereafter Mg.). Attachment B lists a number of pollution sources in non-attainment areas and shows for each the costs to control one metric ton of VOC which contributes to the formation of ozone.

In attainment areas there are no hard estimates of the maximum amount being spent, but a number of $250/Mg. (used in EPA's analysis) seems reasonable, and increasing this number to $1000/Mg. does not change our conclusions.

Accordingly, the benefits of pollution control are liberally estimated at $1500/Mg. in non-attainment areas and $250/Mg. in attainment areas. These benefit estimates are then used in combination with cost estimates by EPA for Stage II control and cost estimates by GM for onboard controls to perform the net present value calculations shown in Attachment C.

Attachment D shows graphically the bottom-line results for the four relevant strategies: Stage II controls used only in non-attainment areas, Stage II controls in attainment areas, Stage II controls applied nationwide, and onboard controls. As the chart indicates, the costs of onboard controls would exceed the benefits by over $300 million per year and the costs of nationwide Stage II controls would exceed the benefits by over $70 million per year. However, the benefits of using Stage II controls in non-attainment areas outweigh the costs by over $26 million per year.

The EPA strategies document estimated that onboard controls would be more cost beneficial than Stage II controls. The results of our analysis differ from the EPA results for two basic reasons. First, the benefits of air pollution control in non-attainment areas have been separated from the benefits in attainment areas, the latter having been assigned a substantially lower value. This means the benefits that could be expected from any form of nationwide controls would be substantially less than estimated in the strategies document. Second, the EPA strategies document understates the costs and overstates the benefits of onboard refueling vapor controls.

GM estimates the costs to consumers of refueling vapor controls over and above the cost of the current evaporative emission controls at $30 per vehicle. No more than $2 of that $30 should be credited towards possible improvements to the current evaporative emission control system (which lacks capacity to handle high volatility gasoline). Therefore, the incremental cost of controlling refueling vapors with an onboard system is at least $28/vehicle, not $13 per vehicle as estimated by EPA. Likewise, the relevant benefits should be attributed to the refueling vapors alone. It is our judgment that it is incorrect to count the benefits of improved evaporative emission control as part of the benefits of refueling vapor control in EPA's calculation. (Refueling vapor controls, evaporative emissions and gasoline volatility are discussed in Attachment E.)

These results can be restated in terms of cost-effectiveness. Nationwide Stage II controls cost less and produce more benefits than onboard controls, so they are more cost-effective than onboard controls. In Table 7-28 of the EPA strategies document, cost-effectiveness per cancer is computed after reducing the costs of refueling vapor controls by VOC benefits. Attachment F shows those calculations revised to reflect $1,500/mg in non-attainment areas and $250/mg in attainment areas.

As expected, onboard controls are less cost-effective than nationwide Stage II controls by a factor of six. Stage II controls in non-attainment areas appears to be a cost-effective strategy. Stage II controls in attainment areas control cancer at a cost of at least $8 million per cancer, and there are dozens of public health programs that are far more cost-effective than $8 million per life.

In summary, refueling vapors are a negligible health risk by EPA criteria. It is not cost-beneficial (or cost-effective) to reduce air pollution with onboard refueling vapor controls. It may be cost-beneficial to reduce air pollution with Stage II controls, but only in non-attainment areas.

# # # #

Attachment A

Health Considerations

Refueling vapor controls cannot be justified on the basis of health benefits. The EPA strategies document overstates the health risk to humans for two reasons. First, an API study was used to estimate the risks of gasoline vapors other than benzene. However, the results of the API study are not relevant for the assessment of potential health effects from refueling vapors during gasoline transfers because whole gasoline vapors were used to evaluate the carcinogenic potential rather than fuel vapors actually emitted during the refueling process. (See MVMA comments on EPA strategies document, November 12, 1984, pages 3-5.) Our analysis assumes that the only health risk from refueling vapors is cancer risk due to benzene exposure. Second, the cancer risk from benzene exposure was conservatively assumed to be linear, when the risk is thought to rise exponentially. 1/ The effect of EPA's assessment is to increase the estimate of cancer risk at low levels of exposure to benzene by a factor of 40.

According to Professor Lave of Carnegie-Mellon University, the EPA Carcinogen Assessment Group considers risks in the area of one cancer incidence per 100,000 to 1,000,000 lifetimes as "negligible". (See Lester Lave, General Motors Submission in Opposition to the Initial Determination of a Defect in 1978-80 'A' Car Rear Axles, May 4, 1983, p. 6.) Using MVMA benzene cancer incidence estimates, the health risk represented by gasoline vapors is less than one cancer in 40 million lifetimes. Even using EPA benzene cancer incidence estimates, the health risk is on the order of one incidence in one million lifetimes.

Currently, there are approximately 100 million drivers and 50 driving years per lifetime, which amounts to two million driver lifetimes per year. MVMA estimates no more than 0.05 benzene-related cancers per year. When this is divided by the two million lifetimes, the result is one cancer per 40 million lifetimes. Similarly, when the EPA estimate of two benzene-related cancers per year is divided by the two million lifetimes, the result is one cancer per one million lifetimes.

Refueling vapor controls cost at least $4 billion per cancer incidence reduction ($62 million/.021 cancers). Even under the EPA's assumption, refueling vapor controls cost at least $75 million per cancer incidence reduction ($62 million/.83 cancers). [2]

If the nation were to embark on a program to prevent the 700,000 annual cancer occurrences at the rate of $75 million per cancer, the total expenditures would be over $50 trillion per year, which is over 15 times the current gross national product.

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[1] MVMA, "Comments on EPA Strategies Document," p. 7.

[2] The EPA strategies document estimates that Stage II non-attainment area controls would cost $62 million per year, and would reduce cancer incidences by .83 per year. The MVMA "Comment on EPA Strategies Document" shows that cancer risk from benzene rises exponentially with exposure, not linearly as assumed by the EPA, and that correction of this error requires multiplying EPA cancer incidence rates by 12/470 (e.g., .021 is .83 x 12/470).

Attachment B

Selected Cost-Effectiveness Estimates (1984 Economics)

Pollution Source	Annual Cost ($ Million)	Annual VOC Reduction (Metric Tons)	Cost-Effectiveness ($/Metric Ton	Reference/ Notes
Coke Ovens	189	218,000	870	A
Foundries	135	136,000	990	A
Letterpress & Lithography	343	245,000	1,400	A
Stage II	857	618,000	1,390	A
Inspection/ Maintenance	---	---	1,070	B
Auto Coatings	---	---	1,480	B
RVP Reduction of 2 psi	296	259,000	1,140	C

Reference/Notes

A: March, 1976, Interagency Task Force Report on Motor Vehicle Goals Beyond 1980. Costs updated to 1984 via CPI.

B: July, 1983, Regulatory Impact Analysis for Revised Gaseous Emission Regulations for 1984 and Later Model Year Light-Duty Trucks. Costs updated to 1984.

C: "MVMA Position on Summer Gasoline Volatility and Evaporative Emissions" MVMA, Detroit, Michigan, July, 1985.

Source: "MVMA Position on Summer Gasoline Volatility and Evaporative Emissions." MVMA, Detroit, Michigan, July 1985.

Attachment C

Net Present Value (NPV) Analysis of Four EPA Strategies

Strategy	$ millions/year
A. Stage II (Non-Attainment Areas with Inspections	
°Benefits -- $1,500/Mg in NAA x .0590 Mg x 10^6/yr.88.500	
°Cost	- 62.000
°NPV	+ 26.500
B. Stage II (Attainment Areas with Inspections)	
°Benefits -- $250/Mg in AA x .0880 Mg x 10^6/yr.	22.000
°Cost	-121.000
°NPV	- 99.000
C. Stage II (Nationwide with Inspections)	
°Benefits -- $1500/Mg. in NAA x .0590 Mg x 10^6/yr.	88.500
$ 250/Mg. in AA x .0880 Mg x 10^6/yr.	22.000
	110.500
°Cost	-183.000
°NPV	- 72.500
D. Onboard Controls	
°Benefits -- $1500/Mg. in NAA x .0550 Mg x 10^6/yr. 82.500	
$ 250/Mg. in AA x .0820 Mg x 10^6/yr.	20.500
	103.000
°Cost	-429.000
°NPV	-326.000

Notes on Attachment C

1) Benefit estimates are derived from Tables 1-12 and 7-25 in the EPA strategies document.

2) Annualized emission reductions have been split into non-attainment areas (NAAs) and attainment areas (AAs).

3) The costs of the onboard controls combined with evaporative emission controls have been scaled up to reflect $28/vehicle instead of $13/vehicle. (See Attachment E.) Even if the EPA figures are used, the costs of onboard controls exceed the benefits by $96 million per year.

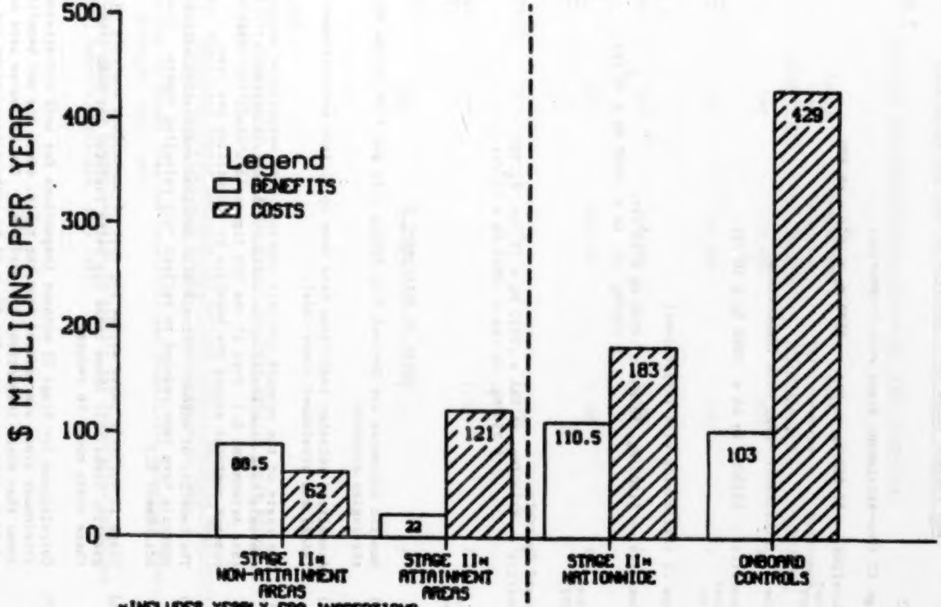
4) The benefits of onboard controls with combined evaporative emissions controls have been reduced to reflect only refueling vapors. (See Attachment E.)

6) Stage II controls costs assume the cost of installing controls on existing gasoline tanks. If these tanks are being replaced for some other reason, these costs could be reduced.

7) Calculations for Stage II without inspections for both non-attainment and attainment areas are omitted from the table, since the net benefits were lower than where inspections are performed. The estimates were net benefits of $3.5 million per year for Stage II NA without inspections and -$76.0 million per year for Stage II nationwide without inspections.

Attachment D

COST-BENEFIT ANALYSIS OF FOUR CONTROL STRATEGIES



*INCLUDES YEARLY EPA INSPECTIONS

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Attachment E

Refueling Vapors, Evaporative Emissions, and Gasoline Volatility

This analysis is based on computing incremental benefits and incremental costs, and it corrects two errors in The EPA strategies document regarding the costs and benefits of onboard controls.

Since 1971, all new cars have had evaporative emission control systems designed to function on gasoline with volatility of 9 psi Reid Vapor Pressure (RVP). However, most of those systems are inadequate to provide the same level of controls at current commercial gasoline RVP levels which in several northeastern cities are as high as 11.5 psi.[1/] With respect to evaporative emissions, there are two solutions. One is to reduce gasoline RVP to 9 psi at a cost of about 1 to 2 cents per gallon; the other is to increase the capacity of the current evaporative emission control systems.

So far, General Motors has not identified what modifications to the current evaporative emission control system would be required to handle high volatility gasoline. The solution could possibly include increasing the size of the present charcoal-filled canister by 50-100 percent or more. This increased canister size by itself would increase costs to consumers by no more than $2/vehicle.

Hardware costs for an additional onboard refueling vapor control system is estimated to increase costs to consumers by about $30 per vehicle. Part of this refueling vapor control system is a large canister three-to-four times the size of the current evaporative emission canister. If this large canister could be shared with a higher capacity evaporative emission control system, then the incremental cost of adding a refueling vapor control system to a vehicle that would be required to have a higher capacity evaporative emission control system would be no less than $28/vehicle.

While a combination of the evaporative emission system with the onboard refueling control system might provide the added vapor storage capacity needed for higher RVP gasoline, it would not significantly impact the requirement to purge those stored vapors from the canister when the engine is running. Current emission systems (meeting the 9 RVP fuel requirement) must purge an average of 2.5 to 3.5 grams per mile (g/mi) from the canister. The onboard refueling control system, on the other hand, would require a purge rate of only about 1/4 g/mi. This purge rate would be sufficient to insure that 75 grams of refueling vapors will be purged over about 300 miles of driving. However, if the evaporative emission system must function on gasoline with 11.5 RVP the purge requirement would increase to at least 4 to 5 g/mi.

Either commercial gasoline volatility must be reduced or the capacity of the evaporative emission control system must be increased. If gasoline volatility is reduced, the incremental cost of an onboard refueling vapor control system is $30/vehicle. If the evaporative emission control system capacity must be increased to handle gasoline with higher volatility, then the incremental cost of an onboard refueling vapor control system is at least $28/vehicle. In either case, only the vapors recovered by the refueling system, not the vapors recovered by the improved evaporative emission control system or the vapor reduction due to lower volatility gasoline, must be considered in determining the incremental benefit.

1/ Evaporative emissions are the vapors that escape from the fuel tank and the carburetor vents from gasoline-powered vehicles during normal operating and parking sequences. The control regulations which first applied to 1971 model cars defined a regulatory emission standard and a laboratory test procedure, including the requirement to test with 9 psi RVP fuel which was near the national average for commercial summer fuel. Since that time, the national average summer gasoline RVP has increased to more than 10 psi, while New York City, Chicago, Detroit and other cities have averages of about 11.5.

Attachment F

Cost-Effectiveness of Four EPA Strategies

Regulatory Strategy	Annualized Cost[a] ($million/yr.)	Annualized Incidence Reduction (Bz)[b]	Annualized Incidence Reduction (Bz + Gv)[c]	Cost[d,e] ($million per cancer incidence)	
				Bz	Bz + Gv
Stage II NAA	0	.83	10.07	0	0
Stage II AA	99.0	1.09	11.70	90.8	8.5
Stage II Nation-wide	72.5	1.92	21.77	37.8	3.3
Onboard	326.0	1.44	16.92	222.4	19.3

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[a] From Attachment C

[b] Bz = Benzene

[c] Bz + Gv = Benzene plus Gas Vapors, "plausible upper limits based on rat studies"

[d] Zero indicates that the VOC benefits outweigh the costs

[e] Assuming NAA Benefit of $1,500/Mg and AA Benefit of $250/Mg

Attachment D

ADDITIONAL CLEAN AIR ACT AMENDMENTS

- National Ambient Air Quality Standards -- Attainment

The Clean Air Act (CAA) requires all areas of the nation to meet the National Ambient Air Quality Standards (NAAQS) for Carbon Monoxide (CO) and Ozone (O_3) no later than the end of 1987. Some areas of the country will fail to meet this deadline. The CAA requires the United States Environmental Protection Agency (EPA) to apply severe sanctions for failure to comply -- banning new construction, withholding of sewer, highway and air pollution control grants -- if this deadline is not met.

The deadline is causing considerable difficulty in permitting plants and the situation is expected to become even more difficult as we approach the 1987 deadline. Further, we expect one of the unintended effects will be distortions in economic growth and employment. It is unlikely that these distortions will be offset by the uncertain environmental benefits that accrue from adhering to the current deadline. In fact, adherence to the deadline threatens the credibility of the whole air pollution control program in this country.

EPA faces a dilemma. It must impose sanctions even through they may retard the air quality progress, while impeding water quality and highway improvements that are needed for economic development. This dilemma is caused by the failure of the law to recognize the difficulty of rapidly improving air quality, the imprecision of the NAAQS, and the benefits of maintaining continuing progress in many societal areas versus the negative impact the current law would impose.

For example, actual CO non-attainment is generally limited to small areas (hot spots) near congested street intersections. Few people spend more than a few minutes in such areas. Therefore, CO non-attainment is not believed to be a serious national problem. Moreover, the President's Council on Environmental Quality recognizes the marginal nature of CO non-attainment and projects national attainment within a few years for all but the most severely impacted areas, e.g. California.

Ozone non-attainment is much more pervasive. In addition, ozone reductions have not been as dramatic as CO reductions because of the multiplicity of contributing sources. Although ozone levels have improved, it is clear that national compliance by the end of 1987 is impossible. For example, Los Angeles ozone levels are now about one-half what they were in the 1960s but are still more than twice the NAAQS.

Also, some of the NAAQSs are still based on rare events, i.e., once a year concentrations, etc. Such values bear little relationship to human exposure and especially the exposure of the high risk portion of the population.

General Motors recommends that the CAA be amended to provide that compliance with the NAAQS be based on more robust statistical measures, that the final effective date of December 31, 1987, for attainment of the CO and O_3 NAAQS be extended, and that the severe sanctions for failure to meet the deadlines be moderated. These steps would maintain air quality progress while eliminating the threat to future economic growth in noncompliance areas.

- Passenger Car CO Standard

The 3.4 g/mi CO standard for passenger cars is proving extremely difficult to achieve in-use, raising the potential of high cost recalls. Since the CO air quality is continuing to improve, and few areas of the country (outside of California) will exceed the NAAQS for CO by 1990, GM believes that a relaxation of the current CO standard to 7.0 g/mi would not significantly affect air quality or measurably increase the time to compliance with the CO NAAQS, but would substantially reduce the risk of noncompliance. Such a change has been widely recommended.

GM recommends amending the CAA to provide a 7.0 g/mi CO standard. If necessary, the 3.4 g/mi standard could remain as a certification standard, with a 7.0 g/mi standard as the in-use standard.

- Alternatives to Recall

The risks and costs of current recall procedures often are out of proportion to the air quality benefit they provide. This is especially true for recalls for marginal noncompliance where no identifiable defect exists. In such cases, the costs of recalls approach or exceed $10,000 per ton of hydrocarbon (HC) removed. Figure 1 demonstrates the extremes of cost-effectiveness for General Motors recalls to date.

GM believes equivalent or greater air quality benefit could be achieved at substantially lower cost by allowing the use of alternative means of achieving the emission reductions. GM recommends that the Clean Air Act be amended to increase the administrative flexibility of the Agency in approving such alternatives to recalls.

o Heavy-Duty Engine Emission Standards

The CAA mandates that the Administrator of the EPA prescribe reductions in heavy-duty engine (HDE) emissions of at least 90% for HC and CO emission and 75% for nitrogen oxide (NOx) emissions. It is not likely that such requirement can be justified, particularly for heavy-duty trucks which spend little time in pollution-impacted urban areas. In fact, EPA's estimate shows a 90% reduction standard would reduce total HC emissions by less than 1%.

For heavy-duty gasoline-powered engines (HDGEs) to meet these HC and CO emission standards, the use of oxidizing catalytic converters is required. However, development data show conclusively that in order to control to these levels, high temperatures are generated which destroy the catalytic systems needed to achieve such stringent standards. Clearly, such stringent levels are not technologically feasible. Furthermore, catalysts needed to control NOx emissions tend to be even more susceptible to high temperature damage than the oxidizing catalysts, making the NOx requirement even more infeasible.

Finally, there is no known technology for heavy-duty diesel engines (HDDEs) to achieve the mandate 75% reduction in NOx emission levels. Adoption of such stringent NOx standard would eliminate diesel engines from the market.

Therefore, GM recommends the CAA be amended to remove the requirements for specific (and arbitrary) fixed percentage reductions in HDE emissions. The Administrator should be given the flexibility to set appropriate standards.

- Light-Duty Truck and Heavy-Duty Engine Useful Life

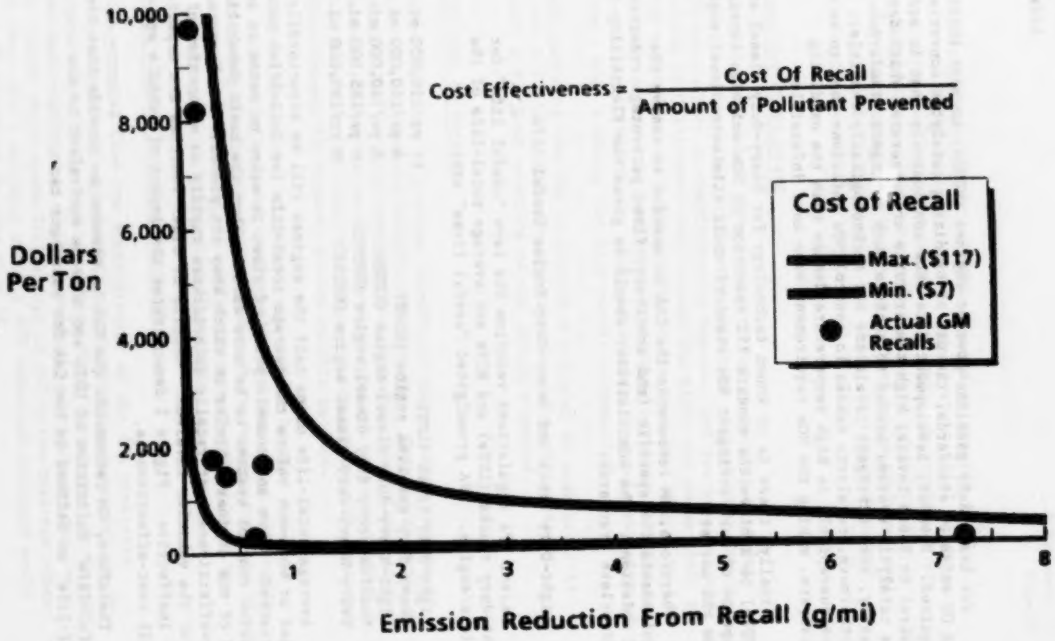
Recent EPA regulations redefine the term "useful life" for light-duty trucks (LDTs) and HDEs and average total-life of the vehicle/engine. EPA promulgated "useful lives" are:

Light-duty truck (LDT)	11 yr/120,000 mi.
Heavy-duty gasoline engine (HDGE)	8 yr/110,000 mi.
Light-heavy-duty diesel engine (LHDDE)	8 yr/110,000 mi.
Meadium-heavy duty diesel engine (MHDDE)	8 yr/185,000 mi.
Heavy-heavy-duty diesel engine (HHDDE)	8 yr/290,000 mi.

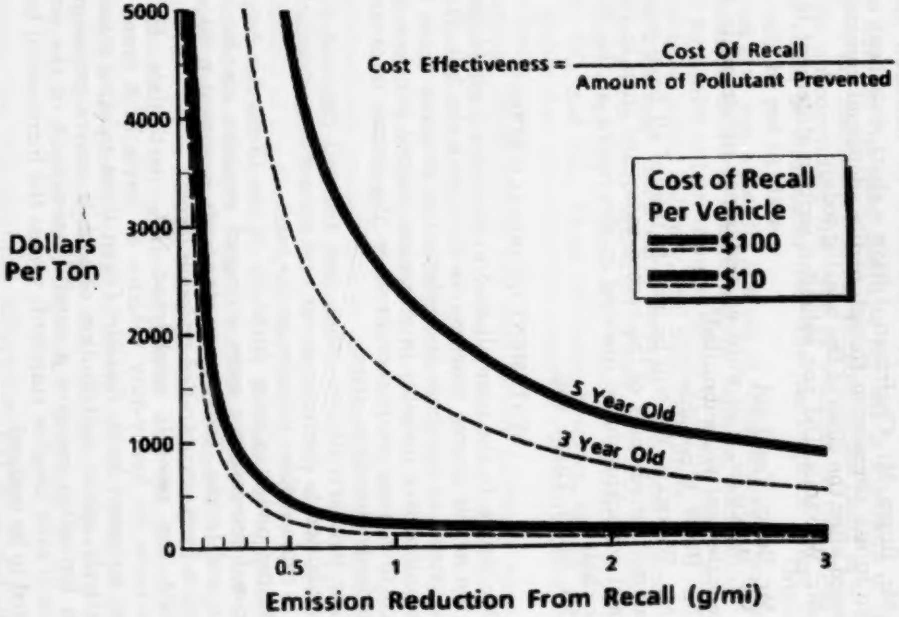
Average total-life means half the engines will be structurally failed or worn-out before the average total-life (or full-life) period is reached. From an economic point of view, it makes no sense to require emission control systems to be more durable than the basic durability of half of the engines/vehicles on which they are placed. Furthermore, the cost-effectiveness of recalls deteriorates rapidly as a function of the age of the vehicles involved. Recalls of older vehicles are especially cost ineffective. Figure 2 demonstrates the impact of vehicle age on recall cost-effectiveness.

Therefore, GM recommends the CAA be amended to provide that the "useful-life" definition of LDTs and HDEs be equivalent to the "half-life" as defined in the CAA for passenger cars.

Recall Cost Effectiveness



Recall Cost Effectiveness



Mr. WAXMAN. Thank you very much, Dr. Klimisch. Mr. Buist.

Mr. BUIST. Mr. Chairman, I have a short statement and I would like to ask permission though to file additional comments for the record after the close of the hearing today.

Mr. WAXMAN. Did you submit a written statement to us for the record?

Mr. BUIST. Yes, I did.

Mr. WAXMAN. You want an additional statement in addition to the statement you submitted?

Mr. BUIST. If possible.

Mr. WAXMAN. We will be glad to first of all have your prepared statement made part of the record today and then to receive additional comments to be inserted in the record at the discretion of the chair.

Mr. BUIST. Thank you.

STATEMENT OF DONALD BUIST

Mr. BUIST. In the time allotted to me today I would like to speak to the mobile source concerns we have with the bill. The bill does not appear to recognize the substantial progress made to date by the automotive industry in emissions control nor does it acknowledge that even greater progress in the future is assured by the standards already in place.

Our industry, like no other, has and will continue to make its contribution to clean air as our new state-of-the-art vehicles continue to replace older vehicles on the road.

Acting under existing authority in the Clean Air Act, EPA has imposed increasingly more stringent emission standards on both cars and trucks. Today's car standards represent a 90-percent reduction from uncontrolled emission levels.

EPA has recently established NO_x, particulate, HC and CO standards for heavy-duty vehicles at levels EPA found were the most stringent levels feasible. Given these existing standards, the relatively minor contribution of mobile source emissions to acid rain formation requires a careful assessment of the societal impacts of even tougher standards versus the incremental benefits expected to be realized.

We believe the bill would have substantial consumer impacts and let me describe a few examples. First, the bill establishes an NO_x standard for heavy-duty gasoline-powered trucks at 1.7 grams per brake horsepower-hour compared to an EPA standard of 6 grams for 1988 and 5 grams for 1991 and later model years.

A 1.7 gram level of NO_x control for heavy-duty gasoline trucks simply is not feasible at any time in the foreseeable future. As you may know, EPA did give consideration to a 4 gram standard for heavy-duty gasoline engines in its rulemaking but concluded that the necessary technology did not exist and that the standard would, in fact, eliminate such engines from the marketplace.

EPA noted that no air quality gains would be achieved by imposing such a stringent standard because diesel engines would merely displace the gasoline versions. In fact, as recently as last week California reviewed this same issue and concluded that standards more stringent than those promulgated by EPA are not feasible in the near term.

What we have on the easel board to my left is a blowup of the attachment to my statement and the purpose of the chart is to indicate to the subcommittee the type of vehicles or the types of trucks that could be eliminated from the marketplace where this standard would be put in place.

Let me just give you a feel for the use of these trucks. These are special education or rural schoolbus-type vehicles, vanpooling vehicles used for senior citizen transportation in many cases, smaller farm use vehicles, parcel delivery, and EMS type units.

These vehicles most often carry heavier loads and operate at higher temperatures than light-duty trucks. An NO_x standard of 1.7 would require the use of three-way catalysts to control simultaneously HC, CO, and NO_x. These catalysts, however, are even less thermally stable than the oxidation catalysts currently being considered for heavy trucks.

The operating temperatures and load factors normally encountered by these vehicles preclude the use of three-way catalysts.

The bill also diverges from EPA standards in that it divides the light-duty truck diesel NO_x requirements into two-weight categories but groups all gasoline-powered light trucks into one category.

EPA and California found that the heavier gasoline versions faced a substantially greater task in meeting the standards. The gasoline engine HC standard proposed in the bill in conjunction with the 12,000-mile EPA useful life requirement would severely limit availability of the heavier gasoline-powered trucks.

Next, the proposed passenger car NO_x standard is significantly more stringent than today's Federal standard. California has a 0.7 NO_x standard but this standard has been combined with unique California hydrocarbon and carbon monoxide standards that recognize the interaction among the emissions and the difficulty of achieving lower NO_x levels.

Moreover, the air quality impact of moving to a 0.7 NO_x standard is small given the passenger car NO_x emissions represent only about 4.7 percent of total acid deposition according to the EPA studies.

We estimate that the potential differential impact on acid rain would be about 1 percent by the year 2000 and these minor air quality gains would come at an expense of fuel economy.

Our preliminary analysis of a 0.7 standard indicates that it would reduce the fuel economy on some of our products by as much as a half a mile per gallon, a serious customer penalty that would make it even more difficult for Ford to meet the corporate average fuel economy requirements.

[The prepared statement of Mr. Buist follows:]

STATEMENT OF DONALD R. BUIST
FORD MOTOR COMPANY
BEFORE THE SUBCOMMITTEE ON HEALTH AND THE ENVIRONMENT
HOUSE ENERGY AND COMMERCE COMMITTEE

May 1, 1986

I am Don Buist, Director of Ford's Automotive Emissions and Fuel Economy Office. In the time allotted to me today, I would like to speak to the mobile source concerns we have with H.R.4567. The bill does not appear to recognize the substantial progress made to date by the automotive industry in emissions control nor does it acknowledge that even greater progress in the future is assured by the standards already in place.

Our industry, like no other, had and will continue to make its contribution to clean air as our new "state-of-the-art" vehicles continue to replace older vehicles on the road.

Acting under existing authority in the Clean Air Act, EPA has imposed increasingly more stringent emission standards on both cars and trucks. Today's car standards represent a 90% reduction from uncontrolled emission levels. EPA has recently established NO_x, particulate, HC and CO standards for heavy-duty vehicles at levels EPA found were the most stringent levels feasible. Given these existing standards, the relatively minor contribution of mobile source emissions to acid rain formation requires a careful assessment of the societal impacts of even tougher standards versus the incremental benefits expected to be realized. We believe H.R.4567 would have substantial consumer impacts. Let me describe four major examples:

- The bill establishes NO_x standards for heavy-duty gasoline-powered trucks at 1.7 g/bhp-hr (compared to an EPA standard of 6.0 g/bhp-hr for 1988 and 5.0 g/bhp-hr for 1991 and later model years). A 1.7 g/bhp-hr level of NO_x control for heavy-duty gasoline trucks simply is not feasible at any time in the foreseeable future. As you may know, EPA did give consideration to a 4.0 g/bhp-hr standard for heavy-duty gasoline engines in its rulemaking, but concluded that the necessary technology did not exist and that the standard would, in fact, eliminate such engines from the marketplace. EPA noted that no air quality gains would be achieved by imposing such a stringent standard because diesel engines would merely displace the gasoline versions. As can be seen on the attached chart, the vehicles to which this standard would apply most often carry heavier loads and operate at higher temperatures than light-duty trucks. A NO_x standard of 1.7 g/bhp-hr would require the use of three-way catalysts to control simultaneously HC, CO and NO_x. These catalysts, however, are even less thermally stable than the less advanced oxidation catalysts currently being considered for heavy trucks, which control HC and CO only. The operating temperatures and load factors normally encountered by these vehicles preclude the use of three-way catalysts.

The bill also diverges from EPA standards in that it divides the light-duty truck diesel NO_x requirements into two weight categories, but groups all gasoline-powered light trucks into one category. EPA and California found that the heavier gasoline versions faced a substantially greater task in meeting the standards. The gasoline engine HC standard proposed in H.R.4567, in conjunction with the 120,000 mile EPA certification requirement, would severely limit availability of the heavier gasoline-powered trucks. The proposed passenger car NO_x standard is significantly more stringent than today's federal standard. California has a 0.7 gpm NO_x standard, but this standard has been combined with unique California hydrocarbon and carbon monoxide standards that recognize the interaction among the emissions and the difficulty of achieving lower NO_x levels. Moreover, the air quality impact of moving to a 0.7 gpm NO_x standard is small given that passenger car NO_x emissions represent only about 4.7% of total acid deposition according to EPA studies. We estimate that the potential differential impact on acid rain would be about 1% by the year 2000 and these minor air quality gains would come at the expense of fuel economy. Our preliminary analysis of a 0.7 gpm standard indicates that it would reduce the fuel economy on some of our products by as much as 0.5 mpg -- a serious customer penalty that would make it even more difficult for Ford to meet corporate average fuel economy (CAFE) requirements.

Finally, H.R.4567 mandates control of refueling hydrocarbons on a nationwide basis. We believe that regional control of these emissions through the application of "Stage II" gasoline pump controls is unquestionably the most expedient, cost-effective way to provide the HC control desired by those areas of the country which will not be in compliance with the national ambient air quality standard for ozone by December 31, 1987 as required by the Act.

In summary, Ford believes that an effective mobile source control strategy addressing the issues raised by H.R.4567 is already in place. In view of the minor contributions of trucks to NO_x pollution, and the significant level of control already achieved by mobile sources, implementing standards of increased stringency would remove certain products from the marketplace without providing significant environmental benefits. Thank you.

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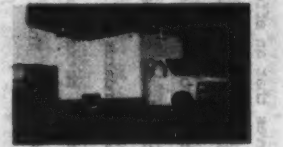
TYPICAL APPLICATIONS LIGHT HEAVY DUTY TRUCKS*

SPECIAL EDUCATION/RURAL SCHOOL BUS

VAN POOLING/ SENIOR CITIZEN TRANSPORTATION

FARM USE

CONSTRUCTION


PARCEL DELIVERY/ EMS UNITS

ROAD SERVICE

RECREATIONAL/ TRAVEL

HAULING

TOWING

*8,500 TO 14,000# GROSS VEHICLE WEIGHT RANGE

Mr. WAXMAN. Thank you very much, Mr. Buist.

Mr. Perkins.

STATEMENT OF STUART R. PERKINS

Mr. PERKINS. Mr. Chairman, on behalf of American Motors Corp. I would like to thank you for extending this invitation to testify before this subcommittee on this very most important topic of acid rain. While there are numerous aspects to this bill, I will limit my remarks to those concerned with the control of mobile source emissions.

Frankly, Mr. Chairman, I am disappointed with the mobile source emission controls proposed in this bill. It mandates a continuing reduction of the mobile source emission levels for model years 1988, 1989, and 1990.

In just 14 months we will begin production of the 1988 models. Yet this bill proposes a 50-percent reduction in the oxides of nitrogen standards on the majority of our light-duty truck line before that production begins.

In addition, the bill requires the EPA Administrator to promulgate regulations to control the emission of gasoline vapors during refueling for any vehicle manufactured after 1988.

Mr. Chairman, just a few years ago the economic conditions of this country and especially the business outlook of the automotive industry were bleak indeed. Drastic measures had to be taken for recovery.

In order to work our own way out of this condition, my company developed a plan, a 5-year plan that involved every one of our 45,000 corporate and dealership employees. Our plan is right on target. We have introduced at least one new product every year.

The last three major products we introduced received national recognition awards. We will be bringing out a major new product each year during the next 3 years. We fully expect these products to also gain equal acclaim. If this bill is enacted as proposed, it will burden our product plans and their implementation.

American Motors supports the stated aim of reducing acid rain. However, we believe the major reductions in acid rain can best be accomplished by the control of emissions from stationary sources.

In order to obtain support for this bill, we recommend that the bill be limited to those components that contribute to the acid rain problem. Specifically, we recommend that the provisions of the bill which change current hydrocarbon regulations be eliminated. Hydrocarbons are not significant contributors to the formation of acid rain.

Any measures to reduce hydrocarbon exhaust emissions, whether legislative or regulatory, deserve additional detailed analysis.

One, hydrocarbon emissions from light-duty trucks are already reduced 95 percent from precontrolled emission levels. Further reduction, as proposed in House bill 4567 would result in only one-tenth of 1 percent further reduction in this country's hydrocarbon emissions.

In addition, it would take over a decade to attain this small increment as the current light-duty truck fleet is retired from service.

Two, hydrocarbon emission control should be concerned only with reactive hydrocarbon, that is nonmethane, emission.

Three, the control of hydrocarbon emissions emanating from vehicle fueling is best accomplished by stage II refueling equipment. Equipment installed at the fuel pump site does not have the size and cost restrictions inherent to onboard equipment.

Furthermore, the entire existing vehicle fleet is controlled as the service station equipment is put in service, instead of waiting for a decade for the existing vehicle fleet to be replaced.

Every vehicle manufactured since 1981 and many others before that are designed to accept gas pump nozzles capable of controlling refueling vapors.

Four, EPA is currently in the midst of promulgating hydrocarbon emission controls in the regulation of gasoline volatility requirements and benzene content of motor fuel. Additional hydrocarbon control legislation cannot be considered separate from these EPA actions.

Mr. Chairman, to date the EPA has been delegated the authority to establish truck emission control levels. We believe that this process should continue since the EPA has the expertise in this area and is better equipped to implement congressional intent.

Again, thank you for inviting American Motors to these hearings. I trust our remarks will be helpful in the markup on this bill.

Mr. WAXMAN. Thank you very much, Mr. Perkins.

Mr. Nield.

STATEMENT OF GEORGE C. NIELD

Mr. NIELD. Good morning; my name is George Nield. I am president of the Automobile Importers of America which I will call AIA. With me this morning is Mr. Dick Penna, our special counsel.

AIA members account for the manufacture of over 90 percent of the vehicles imported into this country. Our most fundamental comment on H.R. 4567 relates to the question of need for the more stringent requirements for motor vehicles.

AIA recognizes the concern of this subcommittee over acid deposition but we are unaware of a substantial scientific basis that would justify the imposition of new technology on motor vehicles that could be very costly for consumers.

Passenger car manufacturers have already reduced tailpipe HC and NO_x emissions by 96 and 75 percent respectively. Light-duty trucks have achieved nearly similar percentage reductions for these pollutants.

As a result, the relative contribution of mobile sources to total emissions is decreasing and very rapidly. For example, the National Commission on Air Quality found that by 1987 the contribution of mobile sources to overall hydrocarbon emissions in major urban areas will be no more than 20 to 30 percent. The relative contribution of mobile sources to total NO_x emissions has been reduced by 75 percent to only 50 percent in the last 10 years and more recently, EPA has determined that this has now been reduced to 35 percent.

Given the limited impact of mobile source NO_x on acid deposition and that even further reductions will be achieved as new vehicles replace older more polluting vehicles, additional or more stringent requirements are just not justified.

In fact, more stringent standards might well reduce the replacement of old vehicles and thus be counterproductive.

Turning to the specific provisions of this bill, section 201(d) would require either onboard vapor-recovery systems or so-called stage II systems installed at service stations.

Stage II is more cost effective than onboard controls and it is already installed and working well in California. It can be effective nationally in about 2 years, where about 10 years would be required if the onboard system is added to all new vehicles.

Also, the installation of stage II systems can be coordinated with EPA's existing leaking underground storage tank program making them even more cost effective.

The imposition of onboard control systems would place enormous burdens on the design of vehicles. Finding a place for what is likely to be a 6- to 7-liter canister will call for a tradeoff on most small cars. In fact, there is concern that consumers would resist purchasing new small vehicles with reduced luggage space or fuel tank capacity along with a significantly higher price tag.

Furthermore, with respect to refueling emissions, the bill misses a most important issue and that is, the volatility of fuel. The Reid vapor pressure of fuel has been allowed to increase over the past several years as refiners use lighter hydrocarbons and alcohol blends to increase octane of the fuel.

If EPA would address this issue by reducing the Reid vapor pressure of gasoline, real progress can be made on evaporative emissions associated with the transfer of fuel and from motor vehicle operation.

Finally, there is one aspect of the vehicle emission control program that truly deserves to be addressed. It is the need to assure that gray market vehicles imported into the United States actually meet applicable emission standards.

Unfortunately, H.R. 4567 fails to address this problem.

During 1981 through 1985, the number of gray market vehicles imported into the United States rose from 2,500 vehicles per year to approximately 60,000 vehicles per year last year.

The California Air Resources Board conducted in-use testing for EPA of low-mileage gray market vehicles and of the 26 gasoline fueled vehicles tested, not one met applicable emission standards. In fact, the mean emission levels for these vehicles exceeded the applicable standards by a factor of over five for HC and were twice as high as the specified NO_x level.

A former executive officer of the California Air Resources Board, Tom Austin, testified before EPA in October 1985 that within a few years the excessive emissions from gray market vehicles could fully offset the benefit of inspection/maintenance programs on all vehicles.

This subcommittee voted to address the gray market problem in 1985. AIA respectfully urges the subcommittee to do likewise again.

I thank the subcommittee for the opportunity to appear before you and will be happy to answer any questions you might have.

[The prepared statement of Mr. Nield follows:]

STATEMENT OF

AUTOMOBILE IMPORTERS OF AMERICA, INC.

Good morning. My name is George C. Nield. I am President of the Automobile Importers of America, Inc. (AIA). AIA is a non-profit trade association that represents U.S. importers of vehicles. As such, AIA members account for over 90% of the vehicles imported into the United States. A membership list of AIA's companies is attached.

I am pleased to have the opportunity to present the views of AIA on H.R. 4567. As background for our comments, it should be noted that AIA companies have been leaders in the development of emission control systems for vehicles. The closed-loop 3-way catalyst system and multi-port fuel injection systems which more precisely meter air-fuel ratio are two of the more notable examples of the innovations developed by AIA companies. Other less well-known, but, nonetheless, important technological advances have been developed and are being used by AIA companies. It is against this background of technological innovation that our comments are being made.

AIA's most fundamental comment on this bill relates to the question of need for more stringent requirements for motor vehicles. AIA recognizes the concern this Subcommittee has over acid-deposition, but we are unaware of a substantial scientific basis that would justify the imposition of new technology on motor vehicles that could be costly to consumers.

Vehicle manufacturers have already reduced tailpipe HC and NOx emissions by 96% and 75% respectively from passenger cars. Light-duty trucks have achieved nearly similar percentage reductions for these pollutants. With respect to hydrocarbons and oxides of nitrogen, the relative contribution of mobile sources to total emissions is decreasing rapidly. For example, the National Commission on Air Quality found that by 1987 the contribution of mobile sources to overall hydrocarbon emissions in major urban areas will be no more than 20-30% depending on the area. Likewise, the relative contribution of mobile sources to total NOx emissions is projected to be approximately 50%. This is a reduction from a 75% contribution during the 1970's. Given the limited impact of mobile source NOx on acid deposition and that even further reductions will be achieved as new vehicles replace older more polluting vehicles, additional or more stringent requirements are not justified. In fact, more stringent standards might well reduce the replacement of old vehicles and thus be counter-productive.

Turning to the specific provisions of this bill, Section 201(d) would direct EPA to promulgate rules within six months of the date of enactment which would require either on-board vapor-recovery systems or so-called "Stage II" systems installed at service stations.

If EPA is to address the refueling issue either on its own initiative or because of this bill, the only proper course would be to require Stage II systems. Stage II is more cost-effective than on-board controls and it is already installed and working well in California. It can be effective nationally in about two years, whereas about ten years would be required if the "on-board" system is chosen. Also, the installation of Stage II systems can be coordinated with EPA's existing leaking underground storage tank program making them even more cost-effective.

The imposition of on-board control systems would place enormous burdens on the design of vehicles. As I am sure the Subcommittee recognizes, imported vehicles tend to be smaller than others in the fleet; thus the problem of finding a place for what is likely to be a 6-7 liter canister is great. This is particularly true in vehicles such as fastbacks and hatchbacks where there is no separate trunk. In fact, there is concern that consumers would resist purchasing new vehicles with reduced luggage space or fuel tank capacity along with a significantly higher price tag.

This concern over space leads to another problem--lead time. Because of the vehicles' smaller size, it is quite possible that sheet metal must be reshaped to accommodate the large cannister. Further, the vehicle still must meet Federal Motor Vehicle Safety Standard (FMVSS) 301--which requires the fuel system to meet stringent performance standards in all types of impacts. To design and test the system, make the structural changes and perform the necessary safety testing to assure compliance with FMVSS 301 is a formidable assignment. If the job can be done at all, it will certainly result in significant cost increases and lead time requirements.

Furthermore, with respect to refueling emissions the bill misses the most important issue--that is, the volatility of fuel. The Reid Vapor Pressure of fuel has been allowed to increase over the past several years as refiners use lighter hydrocarbons to add octane numbers to the fuel. In addition, EPA has allowed to the use of alcohols as octane enhancers. If EPA would address this issue by reducing the Reid Vapor Pressure of gasoline, real progress can be made on the issue of all evaporative emissions associated with the transfer of fuel and from motor vehicle operation.

Turning to the proposed NOx and HC standard revisions contained in Section 201(a) of H.R. 4567, AIA has concerns over the necessity for any new requirements. As stated above, there is little, if any, scientific basis to link these vehicle emissions with acid precipitation, and the emission reductions associated with the proposed standards are not cost-beneficial in addressing acid precipitation. Moreover, the lack of time provided to meet the proposed standards for passenger car NOx, light-duty truck HC and NOx is a serious problem.

Added to the uncertainty associated with this bill are the proposed emission standards in S.2203, which are virtually impossible to meet under any circumstances, but especially in the time frame provided in that bill. The double impact of H.R. 4567 and S.2203 could lead to catastrophic consequences for vehicle manufacturers.

Finally, if there is one aspect of the vehicle emission control program that truly deserves to be addressed, it is the need to assure that gray market vehicles imported into the U.S. meet applicable emission standards. Unfortunately, H.R. 4567 fails to address this problem.

During 1981-1985 the number of gray market vehicles imported into the U.S. rose from 2,500 vehicles per year to approximately 60,000 vehicles per year. Yet, EPA has been totally incapable of developing any meaningful program to regulate these vehicles. For over 5 years EPA has been engaged in a rulemaking proceeding on this topic and to date no rules have been published. Indeed, most of the proposals put forward by EPA would not solve the problem, and there is ample evidence of this.

First, the California Air Resources Board conducted in-use testing for EPA of low-mileage gray market vehicles chosen to eliminate any vehicle which was either modified in a grossly incompetent manner or showed any overt evidence of tampering. Of the 26 gasoline fueled vehicles tested, not one met applicable emission standards. In fact, the mean emission levels for these vehicles exceeded applicable standards by a factor of over 5 for HC and 2 for NOx.

Second, at no time has there been any data submitted to EPA which shows that any gray market vehicle has met applicable emission standards over the 50,000 mile testing program that original manufacturers are required to conduct.

Finally, the former Executive Officer of the California Air Resources Board, Tom Austin testified before EPA in October 1985 that within a few years the excessive emissions from gray market vehicles could offset the effect of inspection/maintenance programs on all vehicles. To allow these vehicles to negate the efforts of the states and the motoring public appears to be at counter-purposes from the goals of the Clean Air Act.

This Subcommittee voted to address the gray market problem in 1982. AIA respectfully urges the Subcommittee to do likewise again.

I thank the Subcommittee for the opportunity to appear before you and will be happy to answer your questions.

Attachment

ALFA ROMEO
BMW
FIAT
HONDA
HYUNDAI
ISUZU
JAGUAR
LOTUS
MAZDA
MITSUBISHI
NISSAN
PEUGEOT
PORSCHE
RENAULT
ROLLS-ROYCE
SAAB-SCANIA
SUBARU
SUZUKI
TOYOTA
VOLVO

Mr. **WAXMAN.** Thank you very much.
Mr. Haenchen.

STATEMENT OF DIETMAR HAENCHEN

Mr. **HAENCHEN.** Mr. Chairman, I welcome the opportunity to express Volkswagen's views on the Acid Deposition Act of 1986, H.R. 4567. I intend to place particular emphasis on the role of the motor vehicle in the acid deposition problem and specifically on the provisions of title II, control of emissions from mobile sources.

However, I would first like to mention that although Volkswagen is not directly affected by the provisions of title I, these provisions could have the effect of increasing energy costs at our Pennsylvania vehicle production facility.

Let me turn now to the issue of the title II; provisions of H.R. 4567. In 1985 EPA reaffirmed the current national ambient air quality standards for NO_2 on the basis that it is sufficiently stringent for protection of public health.

Further, this standard is being met nationwide with the exception of certain areas in California.

California is currently reviewing various approaches to reach attainment for NO_2. It also has the authority to set its own vehicle emission standards and therefore broad discretion in achieving the NO_2 standard.

With respect to the emission of oxides of nitrogen and its conversion to acid deposition, nationwide the contribution of motor vehicles is relatively small. In light of these conditions, adoption of the more stringent 0.7 grams per mile NO_x emission standard for motor vehicles is not necessary for attainment of the national air quality standards for NO_2 and will have only limited significance in the control of acid deposition.

Volkswagen is also concerned that the NO_x standard of 0.7 grams per mile as proposed is required to be met by all cars including diesel passenger cars.

The standard fails to consider the difficulties that diesel-powered vehicles have in attaining this NO_x level. Volkswagen is among the minority of automobile manufacturers still offering a diesel-powered vehicle in the U.S. small car market.

We would like to continue to offer this vehicle type since diesel technology may once again prove worthwhile in the event the United States experiences fuel shortages and market demand for fuel efficient vehicles increases.

While Volkswagen's production diesel engines are both efficient and clean, they are at their design limit in terms of low levels of exhaust emissions. Further reduction of the NO_x emission levels of our diesel engine is not feasible. If technology can be developed which meets the tougher NO_x standards, such technology would cause diesel particulate and hydrocarbon emissions to increase to unacceptable levels.

We are convinced that the 0.7 gram per mile NO_x emission standard is going to be the final blow for diesel engine technology in passenger cars.

Since the current market share of diesel vehicles is very low requiring diesel passenger cars to certify a 0.7 grams per mile NO_x

emission standard would have a negligible impact in improving air quality.

H.R. 4567 also includes provisions related to hydrocarbon emissions. For light-duty trucks EPA is already considering establishing more stringent standards through rulemaking. Inclusion of specific light-duty truck standards in H.R. 4567 is therefore unnecessary.

The bill includes another HC control provision which directs EPA to promulgate regulations requiring the installation of control systems for the recovery of HC vapors emitted during vehicle refueling.

EPA is actively investigating the need for and the feasibility of these vapor recovery systems. However, EPA has not yet determined whether or not there is an environmental need for refueling vapor control. Inclusion of specific refueling vapor control requirements in H.R. 4567 is unnecessary in view of EPA's concentrated efforts in addressing this issue.

If the subcommittee should decide to amend title II of the Clean Air Act, I suggest that it consider amending other mobile source provisions as well. Foremost among these is the concept of emission averaging.

It has long been argued that there is no logic to environmental laws that permit measuring average emission in the air to determine air quality, yet prohibit using this averaging approach for determining automobile emission compliance.

This concludes my prepared remarks. I would be happy to answer any questions you may have.

[The prepared statement of Mr. Haenchen follows:]

STATEMENT
OF
VOLKSWAGEN OF AMERICA, INC.

MR. CHAIRMAN, MEMBERS OF THE SUBCOMMITTEE, I AM DIETMAR HAENCHEN, EXECUTIVE ENGINEER OF THE VEHICLE REGULATIONS DEPARTMENT AT VOLKSWAGEN OF AMERICA, INC. (VOLKSWAGEN). I WELCOME THE OPPORTUNITY TO EXPRESS MY COMPANY'S VIEWS ON THE "ACID DEPOSITION ACT OF 1986," H.R. 4567.

AS A REPRESENTATIVE OF AN AUTOMOBILE MANUFACTURER, I INTEND, IN MY COMMENTS, TO PLACE PARTICULAR EMPHASIS ON THE ROLE OF THE MOTOR VEHICLE IN THE ACID DEPOSITION PROBLEM AND SPECIFICALLY ON THE PROVISIONS OF TITLE II - CONTROL OF EMISSIONS FROM MOBILE SOURCES. HOWEVER, I WOULD FIRST LIKE TO MENTION THAT ALTHOUGH VOLKSWAGEN IS NOT DIRECTLY AFFECTED BY THE PROVISIONS OF TITLE I, THESE PROVISIONS COULD HAVE THE EFFECT OF INCREASING ENERGY COSTS AT OUR PENNSYLVANIA VEHICLE PRODUCTION FACILITY.

LET ME TURN NOW TO THE ISSUE OF THE TITLE II PROVISIONS OF H.R. 4567. IN 1985 EPA REAFFIRMED THE CURRENT NATIONAL AMBIENT AIR QUALITY STANDARD (NAAQS) FOR NO_2 ON THE BASIS THAT IT IS SUFFICIENTLY STRINGENT FOR PROTECTION OF PUBLIC HEALTH. FURTHER, THIS STANDARD IS BEING MET NATIONWIDE, WITH THE EXCEPTION OF CERTAIN AREAS IN CALIFORNIA.

CALIFORNIA IS CURRENTLY REVIEWING VARIOUS APPROACHES TO REACH ATTAINMENT FOR NO_2. IT ALSO HAS THE AUTHORITY TO SET ITS OWN VEHICLE EMISSION STANDARDS AND THEREFORE BROAD DISCRETION IN ACHIEVING THE NO_2 STANDARD.

WITH RESPECT TO THE EMISSION OF OXIDES OF NITROGEN (NO_X) AND ITS CONVERSION TO ACID DEPOSITION, NATIONWIDE THE CONTRIBUTION OF MOTOR VEHICLES IS RELATIVELY SMALL. IN LIGHT OF THESE CONDITIONS, ADOPTION OF THE MORE STRINGENT 0.7 G/MILE NO_X EMISSION STANDARD FOR MOTOR VEHICLES IS NOT NECESSARY FOR ATTAINMENT OF NAAQS FOR NO_2 AND WILL HAVE ONLY LIMITED SIGNIFICANCE IN THE CONTROL OF ACID DEPOSITION.

VOLKSWAGEN IS ALSO CONCERNED THAT THE NO_X STANDARD, OF 0.7 G/MI AS PROPOSED, IS REQUIRED TO BE MET BY ALL CARS, INCLUDING DIESEL PASSENGER CARS. THE STANDARD FAILS TO CONSIDER THE DIFFICULTIES THAT DIESEL-POWERED VEHICLES HAVE IN ATTAINING THIS NO_X LEVEL. VOLKSWAGEN IS AMONG THE MINORITY OF AUTOMOBILE MANUFACTURERS STILL OFFERING A DIESEL-POWERED VEHICLE IN THE U.S. SMALL CAR MARKET. WE WOULD LIKE TO CONTINUE TO OFFER THIS VEHICLE TYPE SINCE WE BELIEVE IT IS IMPORTANT TO PRESERVE PASSENGER CAR DIESEL TECHNOLOGY. PRESERVATION OF THIS TECHNOLOGY IS IMPORTANT BECAUSE IT WOULD CONTINUE TO PROVIDE A PRODUCT TO A SPECIFIC SEGMENT OF THE MARKET AND ITS CONTINUED AVAILABILITY ENCOURAGES FURTHER DEVELOPMENT AND REFINEMENT. CONTIUNED DEVELOPMENT OF THIS TECHNOLOGY MAY ONCE AGAIN PROVE WORTHWHILE IN THE EVENT THE UNITED STATES EXPERIENCES FUEL SHORTAGES AND MARKET DEMAND FOR FUEL EFFICIENT VEHICLES INCREASES.

WHILE VOLKSWAGEN'S CURRENT TECHNOLOGY DIESEL ENGINES ARE BOTH EFFICIENT AND CLEAN, THEY ARE AT THEIR DESIGN LIMIT IN TERMS OF LOW LEVELS OF EXHAUST EMISSIONS. FURTHER REDUCTION OF THE NO_X EMISSION LEVELS OF OUR DIESEL ENGINE IS NOT TECHNOLOGICALLY FEASIBLE, PARTICULARLY IN CONJUCTION WITH REQUIREMENTS TO MEET VERY STRINGENT EMISSION STANDARDS FOR OTHER POLLUTANTS. IF TECHNOLOGY CAN BE DEVELOPED, WHICH MEETS THE TOUGHER NO_X STANDARDS, SUCH TECHNOLOGY WOULD CAUSE DIESEL PARTICULATE AND HYDROCARBON EMISSIONS TO INCREASE TO UNACCEPTABLE LEVELS. WE ARE CONVINCED THAT THE 0.7 G/MILE NO_X EMISSION STANDARD IS GOING TO BE THE FINAL BLOW FOR DIESEL ENGINE TECHNOLOGY IN PASSENGER CARS.

SINCE THE CURRENT MARKET SHARE OF DIESEL VEHICLES IS VERY LOW, REQUIRING DIESEL PASSENGER CARS TO CERTIFY A 0.7 G/MILE NO_X EMISSION STANDARD WOULD HAVE A NEGLIGIBLE IMPACT IN IMPROVING AIR QUALITY.

H.R. 4567 ALSO INCLUDES PROVISIONS RELATED TO HYDROCARBON (HC) EMISSIONS. WITH REGARD TO THE HC STANDARD FOR LIGHT-DUTY TRUCKS EPA IS ALREADY CONSIDERING ESTABLISHING MORE STRINGENT STANDARDS THROUGH THE RULEMAKING PROCESS. INCLUSION OF SPECIFIC LIGHT-DUTY TRUCK STANDARDS IN HR. 4567 IS THEREFORE UNNECESSARY.

THE BILL INCLUDES ANOTHER HC CONTROL PROVISION WHICH AUTHORIZES EPA TO PROMULGATE REGULATIONS REQUIRING THE INSTALLATION, IN VEHICLES OR AT SERVICE STATIONS, OF CONTROL SYSTEMS FOR THE RECOVERY OF HC VAPORS EMITTED DURING VEHICLE REFUELING. EPA IS ACTIVELY INVESTIGATING THE NEED FOR AND THE FEASIBILITY OF THESE VAPOR RECOVERY SYSTEMS. HOWEVER, EPA HAS NOT YET DETERMINED WHETHER OR NOT THERE IS AN ENVIRONMENTAL NEED FOR REFUELING VAPOR CONTROL. INCLUSION OF SPECIFIC REFUELING VAPOR CONTROL REQUIREMENTS IN H.R. 4567 IS UNNECESSARY IN VIEW OF EPA'S CONCENTRATED EFFORTS IN ADDRESSING THIS ISSUE.

IF THE SUBCOMMITTEE SHOULD DECIDE TO AMEND TITLE II OF THE CLEAN AIR ACT AT THIS TIME, I SUGGEST IT CONSIDER AMENDING OTHER MOBILE SOURCE PROVISIONS AS WELL. FOREMOST AMONG THESE IS THE CONCEPT OF EMISSION AVERAGING. IT HAS LONG BEEN ARGUED THAT THERE IS NO LOGIC TO ENVIRONMENTAL LAWS THAT PERMIT MEASURING AVERAGE EMISSIONS IN THE AIR TO DETERMINE AIR QUALITY, YET PROHIBIT USING THIS AVERAGING APPROACH FOR DETERMINING AUTOMOBILE EMISSION COMPLIANCE.

IN SUMMARY, VOLKSWAGEN RECOMMENDS THE FOLLOWING CHANGES IN H.R. 4567:

1) RETENTION OF THE CURRENT NO_X EMISSION STANDARD FOR PASSENGER CARS AT 1.0 G/MILE, ESPECIALLY FOR DIESEL-POWERED PASSENGER CARS,

2) DELETION OF STRINGENT LIGHT-DUTY TRUCK HC EMISSION STANDARDS IN LIGHT OF EPA'S CURRENT CONSIDERATION OF THIS ISSUE,

3) DELETION OF THE REQUIREMENTS PERTAINING TO REFUELING HC VAPOR CONTROL ON THE BASIS THAT THE NEED FOR SUCH CONTROL HAS NOT BEEN ESTABLISHED AND,

4) CONSIDERATION OF OTHER CLEAN AIR ACT REVISIONS INCLUDING AN EMISSION AVERAGING STRATEGY FOR MOTOR VEHICLES.

THIS CONCLUDES MY PREPARED REMARKS. I WOULD BE HAPPY TO ANSWER ANY QUESTIONS YOU MAY HAVE AT THIS TIME.

Mr. **Waxman**. Thank you very much for those comments. Let me start my questions with Mr. Klimisch. Two years ago you testified before this subcommittee and agreed with me that available scientific evidence pointed to the need to reduce sulfur dioxide emissions.

Your testimony today is not clear on this point. Do you still agree or has your view changed?

Mr. **Klimisch**. No, sir; I agree that sulfur dioxide emissions should be reduced. There are provisions already in place, however, to do that. The question is whether we need more regulations than we have now.

Mr. **Waxman**. The Envoy's report said they are not adequate to deal with it and it is clear from the National Academy of Sciences acid rain studies and their testimony last Congress before this subcommittee that a reduction of sulfur and nitrogen emissions over a widespread area such as Eastern North America will lead to a nearly proportionate reduction in acid deposition over the same area.

Does everyone agree with the National Academy's assessment that sulfur and nitrogen dioxide reduction requirements similar to those in H.R. 4567 would achieve this result? Mr. Klimisch, do you want to start off?

Mr. **Klimisch**. It will decrease the acid in the rain but it won't have the proportionate effect on what that does once it gets in the ecosystem.

Mr. **Waxman**. So you don't agree with that part of the National Academy of Sciences' study?

Mr. **Klimisch**. No.

Mr. **Waxman**. Does anybody else here want to comment on that conclusion?

[No response.]

Mr. **Waxman**. If not, Mr. Robertson, you testified and I quote, "Meeting 0.7 NO_x with the Federal 3.4 CO standard has never been done and represents a difficult technical challenge." I want to strongly challenge that statement.

Isn't it true that virtually all of your engine family is certified to well less than 0.7 NO_x and 3.4 CO in 1986? I have the data in front of me and let me read you the numbers. Isn't it also true that over 90 percent of all cars not just yours but everyone represented here today certified in 1986 were below 0.7 NO_x and 3.4 CO and where are you getting your information?

Mr. **Robertson**. Mr. Chairman, first of all in 1986 we have three-engine families which were specifically certified as 50-State families. In other words, we certified them under a combination of Federal and California standards. They were two-truck families and one emergency vehicle family.

I guess there are two points that I would like to make. First of all, as has been discussed many times before individual vehicles in the certification fleet that may happen to come in below a certain level does not correspond with our ability to certify for 50,000 miles and to comply in use at that level. It has long been a pattern in the industry as you know to deal with variability between vehicles and variability between production vehicles and prototypes that individual certification——

Mr. Waxman. Aren't the certification numbers well below these standards now for over 90 percent of these cars?

Mr. Robertson. Some of our vehicles come in under the particular certification or the emission standards on an individual basis but not necessarily in use, of course.

Mr. Waxman. Wouldn't that be over 90 percent of the cars?

Mr. Robertson. I would have to count them to see. I don't know, sir.

Mr. Waxman. I would submit that that is the case and so it is a little bit different than what you are representing to us that an occasional car meets that standard. When I review the certification data, I see an effort on the part of auto industry to certify to these numbers so as to essentially have a one-car strategy. That is complying with both the California 0.7 NO_x standard and the U.S. 3.4-gram-per-mile standard on almost the entire fleet so that you can sell your cars anywhere in the United States without technical modifications and this makes sense.

It also means that you can't credibly make the claim that it can't be done. I would like to introduce this EPA certification data into the record at this time without objection.

[Testimony resumes on p. 138.]

[Information to be furnished follows:]

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ARLINGTON, VIRGINIA [illegible]

(703) 241-1297
[illegible]

January 21, 1986

Mr. Curtis Moore
Senate Committee on Environment
and Public Works
Dirksen Senate Office Building, Rm 4210
Washington
D.C.

Dear Curtis,

I have had an opportunity to take a closer look at the preliminary 1986 Certification Data for passenger cars as I promised. Attachment 1 lists all of the data I have obtained in alphabetical order by manufacturer while Attachment 2 ranks the data for each pollutant from highest to lowest. Using this second listing, it is easy to select the cleanest 25% of the data to be about:

NOx = 0.25 gms/mile
CO = 1.3
HC = 0.16
Particulate = 0.18

Figures 1 and 2 present the data graphically for the gaseous pollutants and particulate, respectively. Just glancing at these curves, one can see how far the technology has improved. For example, look how many cars are below about 2 grams/mile CO, or 0.4 NOx or about 0.2 HC. For particulate it is apparent that the California standard of 0.8 which is scheduled to go into effect in 1989 is already being achieved by the two models certified with traps.

I looked at a couple of other relationships which may be of interest to you. Figure 3 plots the NOx data versus weight and indicates that the scatter is very widespread and that they are not closely related. Figure 4 shows the same data for diesel cars only while Figure 5 shows NOx and particulate both plotted versus weight. The data don't indicate to me that there is very much of a relationship.

Since there are many claims that there is an inherent trade off between NOx and Particulate, I have plotted these versus each other in Figure 6. I still don't see a trade-off. A linear regression of the two indicates an R^2 of only about 0.2, further indicating that there is not much of a relationship between them.

Finally, Figure 7 plots the NOx distributions for gasoline and diesel cars. These data make clear that the gasoline cars are substantially cleaner than the diesels -- 25% of the gasoline cars are below about 0.25 whereas a similar point for the diesel is about 0.8 grams per mile.

I hope this data is useful to you. Please don't hesitate to contact me if you have any questions.

Best regards,

Michael P. Walsh

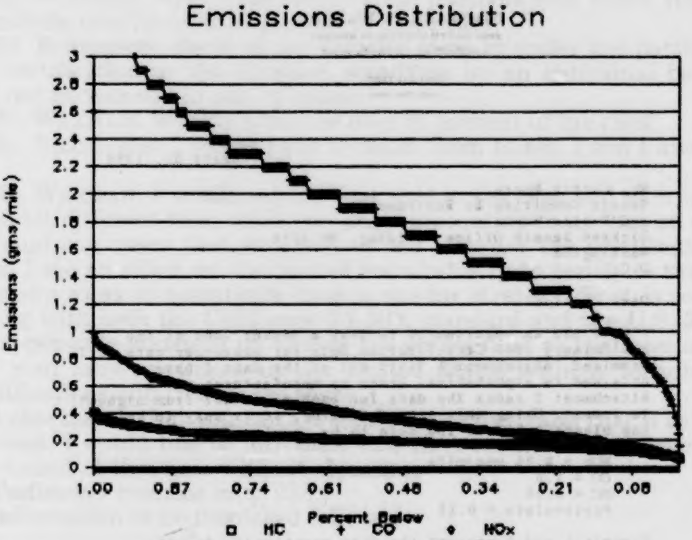

Emissions Distribution
Emissions (gms/mile)
3
2.8
2.6
2.4
2.2
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
1.00
0.87
0.74
0.61
0.48
0.34
0.21
0.08
Percent Below
□ HC
+ CO
◆ NOx

Figure 1

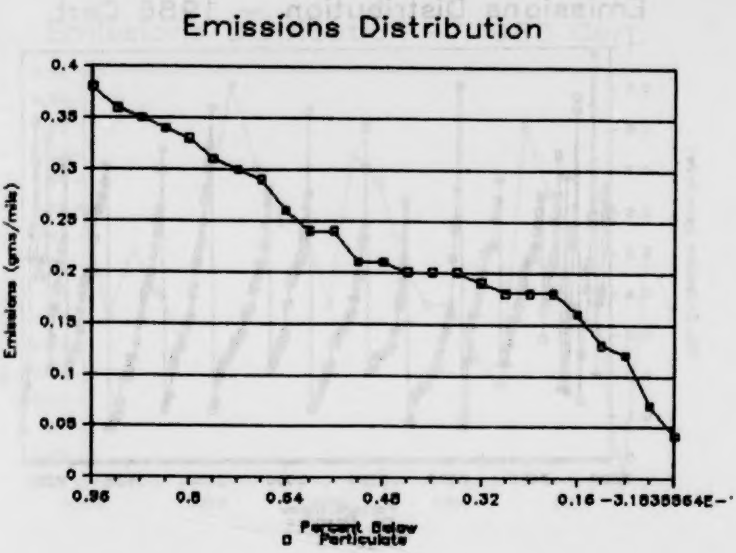
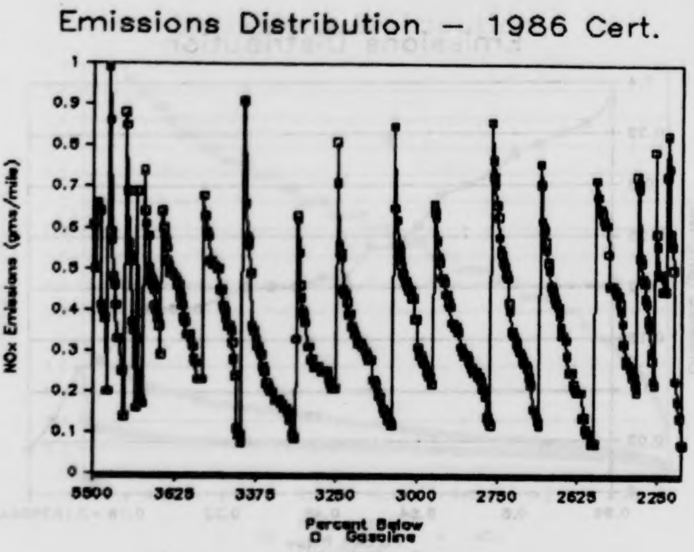

Emissions Distribution
Emissions (gms/mile)
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
0.96
0.8
0.64
0.48
0.32
0.16
-3.1835564E-
Percent Below
Particulate

Figure 2



Emissions Distribution – 1986 Cert.
NOx Emissions (gms/mile)
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
5500
3625
3375
3250
3000
2750
2625
2250
Percent Below
□ Gasoline

Figure 3

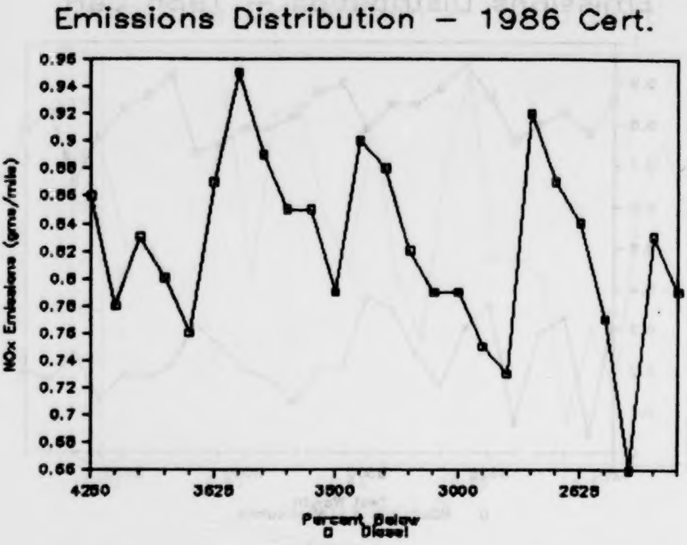

Emissions Distribution — 1986 Cert.
NOx Emissions (gms/mile)
0.96
0.94
0.92
0.9
0.88
0.86
0.84
0.82
0.8
0.78
0.76
0.74
0.72
0.7
0.68
0.66
4250
3625
3500
3000
2625
Percent Below
□ Diesel

Figure 4

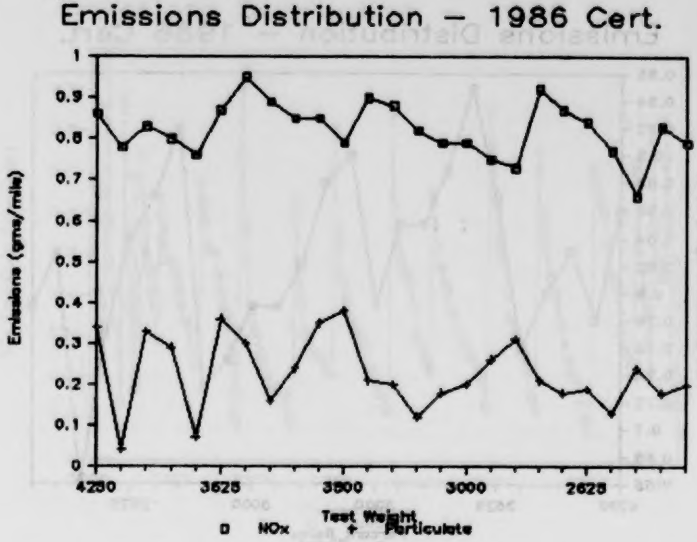

Emissions Distribution — 1986 Cert.
Emissions (gms/mile)
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
4250
3625
3500
3000
2625
Test Weight
□ NOx
+ Particulate

Figure 5

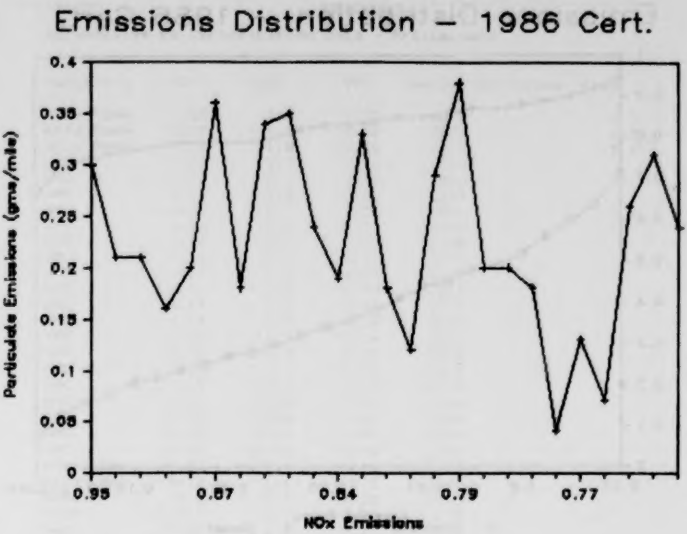

Emissions Distribution — 1986 Cert.
Particulate Emissions (gms/mile)
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
0.95
0.87
0.84
0.79
0.77
NOx Emissions

Figure 6

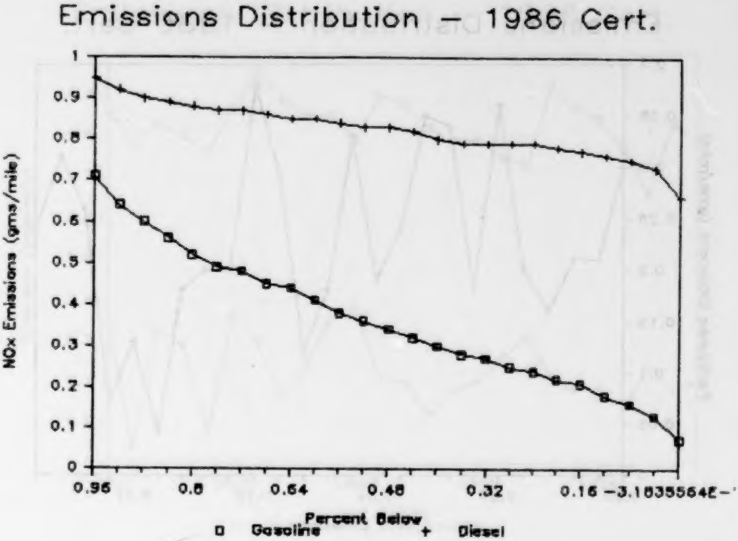

Emissions Distribution – 1986 Cert.
NOx Emissions (gms/mile)
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0.96
0.8
0.64
0.48
0.32
0.16
-3.16355564E-
Percent Below
□ Gasoline
+ Diesel

Figure 7

1/816.DOH

ATTACHMENT 1

Automobiles 86 Certification Data - Preliminary

Manufactu	HC	CO	NOx	Weight	Particles	Evap
Alfa Rome	0.25	1.8	0.25	2875		1.5
Alfa Rome	0.25	1.8	0.25	2875		1.5
Alfa Rome	0.25	1.8	0.18	3125		1.4
AMC	0.22	3.7	0.42	2500		
AMC	0.12	2.1	0.72	2500		
AMC	0.14	1.9	0.53	2375		
AMC	0.13	1.7	0.32	2500		1.4
AMC	0.25	1.7	0.37	2500		
AMC	0.14	1.7	0.57	2625		
AMC	0.14	1.7	0.32	2500		
AMC	0.13	1.6	0.34	2625		
AMC	0.14	1.6	0.34	2625		
AMC	0.14	1.6	0.48	2375		
AMC	0.14	1.5	0.24	2500		
AMC	0.16	1.5	0.24	2500		
AMC	0.18	1.4	0.25	2625		
AMC	0.16	1.4	0.25	2625		
AMC	0.18	1.3	0.23	2375		
AMC	0.12	0.98	0.25	2625		
AMC	0.14	0.98	0.25	2625		
AMC	0.12	0.65	0.46	2500		
AMC	0.13	0.65	0.46	2500		
Aston Mar	0.32	1.4	0.5	5000		
Aston Mar	0.32	1.4	0.5	5000		
Audi	0.3	2.9	0.28	3125		
Audi	0.3	2.9	0.28	3125		
Audi	0.25	2.8	0.22	3375		
Audi	0.23	2.7	0.27	2750		
Audi	0.23	2.7	0.27	2750		
Audi	0.2	2.6	0.23	3250		
Audi	0.28	2.5	0.2	2625		1.4
Audi	0.28	2.5	0.2	2625		
Audi	0.22	2.3	0.21	3375		
Audi	0.24	2.3	0.3	3125		1.2
Audi	0.24	2.3	0.3	3125		1.2
Audi	0.32	2.3	0.35	3375		
Audi	0.3	2.2	0.35	3375		
Audi	0.17	1.9	0.25	3375		
Audi	0.25	1.9	0.37	3625		1.1
Audi	0.24	1.8	0.49	3625		
Audi	0.26	1.4	0.3	3375		
Audi	0.24	1.4	0.1	2625		
Audi	0.24	1.4	0.1	2625		
Audi	0.15	1.3	0.1	2625		
Audi	0.22	1.3	0.36	3375		
Audi	0.15	1.3	0.1	2625		
Bertone	0.24	1.9	0.26	2500		0.56
Bertone	0.24	1.9	0.26	2500		0.56
Bertone	0.25	1.8	0.27	2500		
Bertone	0.25	1.8	0.27	2500		
BMW	0.24	2.7	0.32	3125		
BMW	0.24	2.7	0.32	3125		
BMW	0.31	2.5	0.29	3375		
BMW	0.31	2.5	0.29	3375		

Automobiles 86 Certification Data - Preliminary

BMW	0.29	2.2	0.16	2750		
BMW	0.28	2.2	0.31	2750		
BMW	0.23	2.1	0.17	3875		
BMW	0.23	2.1	0.17	3875		
BMW	0.28	2	0.31	3375		
BMW	0.28	2	0.31	3375		
BMW	0.23	1.8	0.36	3125		
BMW	0.23	1.8	0.36	3125		
BMW	0.21	1.5	0.18	3875		
BMW	0.21	1.5	0.18	3875		
BMW	0.13	1.1	0.87	3625	0.36	
Chrysler	0.17	4.2	0.52	2750		1.2
Chrysler	0.41	3.3	0.39	4250		1.9
Chrysler	0.22	3.2	0.36	2625		
Chrysler	0.21	2.9	0.66	2750		1.5
Chrysler	0.29	2.8	0.28	3500		0.31
Chrysler	0.17	2.7	0.51	3000		
Chrysler	0.33	2.6	0.39	3125		
Chrysler	0.29	2.3	0.45	3125		
Chrysler	0.15	2.3	0.77	2750		
Chrysler	0.28	2.1	0.48	4250		1.6
Chrysler	0.23	2	0.61	2500		
Chrysler	0.22	2	0.68	2500		
Chrysler	0.22	1.9	0.68	2500		
Chrysler	0.23	1.8	0.61	2500		
Chrysler	0.21	1.8	0.53	4000		1.4
Chrysler	0.11	1.7	0.28	3125		0.38
Chrysler	0.17	1.7	0.65	2500		
Chrysler	0.14	1.6	0.43	3250		2
Chrysler	0.22	1.6	0.52	4000		1.4
Chrysler	0.21	1.6	0.53	3125		
Chrysler	0.17	1.6	0.65	2500		
Chrysler	0.26	1.6	0.59	4250		1.7
Chrysler	0.17	1.4	0.39	3125		0.28
Chrysler	0.21	1.3	0.56	3125		
Chrysler	0.17	1.3	0.62	2500		
Chrysler	0.17	1.2	0.62	2500		
Ferrari	0.33	2.9	0.38	3750		1.3
Ferrari	0.35	2.9	0.38	3750		0.84
Ferrari	0.35	2.7	0.41	3500		0.69
Ferrari	0.33	2.7	0.41	3500		1.2
Ferrari	0.29	1.3	0.37	4000		1.3
Ferrari	0.27	1.3	0.37	4000		1.8
Ford	0.21	5.4	0.43	2625		1.4
Ford	0	3.9	0.44	2875		
Ford	0.31	3.7	0.33	3365		1.7
Ford	0.33	3.6	0.56	3000		1.6
Ford	0.33	3.4	0.4	3500		0.77
Ford	0.2	3.4	0.58	3500		1.5
Ford	0.24	3.2	0.58	3500		1.5
Ford	0.15	3.1	0.55	2625		
Ford	0.16	2.9	0.5	3500		0.72
Ford	0.2	2.7	0.5	3500		0.71
Ford	0.14	2.4	0.5	3500		1.2
Ford	0.18	2.3	0.41	3625		
Ford	0.22	2.3	0.71	2750		

Automobiles 86 Certification Data - Preliminary

Ford	0.14	2.3	0.41	3625		
Ford	0.31	2.3	0.86	4250		1.7
Ford	0.17	2.2	0.76	2625		
Ford	0.22	2.2	0.73	2750		
Ford	0.12	2.1	0.24	3500		0.89
Ford	0.18	2.1	0.44	3625		0.7
Ford	0.25	2.1	0.53	3000		0.59
Ford	0.2	2	0.48	2750		
Ford	0.19	1.9	0.49	2750		
Ford	0.14	1.9	0.24	3500		0.88
Ford	0.16	1.9	0.46	3250		1.2
Ford	0.099	1.7	0.36	3500		
Ford	0.12	1.5	0.36	3500		
Ford	0.24	1.4	0.62	3000		
Ford	0.29	1.3	0.54	3125		
Ford	0.2	1.2	0.86	2750		1.4
Ford	0.24	0.79	0.79	3000	0.2	
Ford	0.23	0.73	0.92	2625	0.21	
Ford	0.36	0.55	0.64	3625		
Ford	0.23	0.4	0.41	4250		
Ford	0.18	0.4	0.46	4250		0.79
Ford	0.33	0.37	0.63	3500		
Ford	0.14	0.16	0.35	4000		0.94
Fuji	0.2	5	0.22	2750		
Fuji	0.16	4.5	0.24	2500		
Fuji	0.14	4.2	0.2	2500		
Fuji	0.19	4	0.27	2500		
Fuji	0.12	3.7	0.24	2750		
Fuji	0.14	3.7	0.28	2375		
Fuji	0.13	3	0.33	2750		1
Fuji	0.16	2	0.51	2750		
Fuji	0.21	2	0.36	2875		
Fuji	0.12	2	0.15	2750		0.5
Fuji	0.14	1.9	0.54	2750		
Fuji	0.21	1.7	0.55	3000		
Fuji	0.17	1.7	0.29	2750		
Fuji	0.19	1.6	0.3	2875		
Fuji	0.19	1.5	0.48	3000		
Fuji	0.11	1.5	0.45	2500		
Fuji	0.13	1.4	0.46	2500		
Fuji	0.099	1.3	0.46	2500		
Fuji	0.13	1.3	0.63	2750		1
Fuji	0.14	1.3	0.48	2750		
Fuji	0.17	1.3	0.58	2750		
Fuji	0.098	1	0.36	2375		
GM	0.2	6.1	0.47	3625		
GM	0.15	5.1	0.41	4500		1.4
GM	0.15	5	0.46	3625		
GM	0.16	4.9	0.29	3750		1.6
GM	0.26	3.4	0.59	3500		
GM	0.25	3.2	0.14	2750		0.81
GM	0.28	3.2	0.41	2875		0.61
GM	0.3	3.2	0.33	3625		0.91
GM	0.34	3.2	0.45	3750		
GM	0.18	3.1	0.38	4500		1.9
GM	0.18	3.1	0.38	4500		

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GM	0.28	3.1	0.57	4250	
GM	0.26	3.1	0.56	4000	
GM	0.26	3	0.42	2875	0.61
GM	0.12	2.9	0.4	4500	
GM	0.12	2.9	0.4	4500	
GM	0.25	2.8	0.91	3375	
GM	0.23	2.8	0.25	3250	
GM	0.24	2.8	0.25	3250	1.2
GM	0.25	2.8	0.91	3375	
GM	0.24	2.8	0.13	2750	
GM	0.19	2.8	0.45	3500	
GM	0.19	2.8	0.45	3500	
GM	0.19	2.8	0.45	3500	
GM	0.23	2.8	0.25	3250	1.1
GM	0.24	2.8	0.25	3250	
GM	0.15	2.8	0.33	3875	
GM	0.25	2.8	0.91	3375	
GM	0.37	2.6	0.38	3500	0.99
GM	0.17	2.5	0.52	3500	1.3
GM	0.2	2.5	0.48	3625	
GM	0.11	2.5	0.43	3000	
GM	0.11	2.5	0.46	3000	0.63
GM	0.17	2.5	0.52	3500	1.3
GM	0.17	2.5	0.52	3500	
GM	0.2	2.5	0.51	3625	
GM	0.13	2.5	0.65	3000	0.55
GM	0.24	2.3	0.25	3250	
GM	0.17	2.3	0.51	3500	
GM	0.17	2.3	0.51	3500	0.91
GM	0.24	2.3	0.25	3250	0.57
GM	0.17	2.3	0.51	3500	0.91
GM	0.26	2.3	0.25	3250	
GM	0.26	2.3	0.25	3250	0.67
GM	0.23	2.2	0.66	3375	
GM	0.36	2.2	0.63	3500	1.2
GM	0.16	2.2	0.4	3750	1.4
GM	0.35	2	0.44	3125	
GM	0.35	2	0.44	3125	0.58
GM	0.27	2	0.47	3750	
GM	0.35	2	0.44	3125	
GM	0.22	1.9	0.34	2750	0.99
GM	0.32	1.9	0.5	3750	1.4
GM	0.17	1.8	0.2	3375	
GM	0.16	1.8	0.2	3375	
GM	0.17	1.8	0.2	3375	1.4
GM	0.16	1.8	0.2	3375	1.3
GM	0.13	1.7	0.85	3000	
GM	0.27	1.6	0.28	2875	0.88
GM	0.21	1.5	0.4	2750	0.85
GM	0.29	1.5	0.46	3750	1.5
GM	0.24	1.5	0.29	2875	0.88
GM	0.33	1.5	0.68	3500	1.4
GM	0.19	1.5	0.52	3625	0.72
GM	0.19	1.5	0.49	3625	0.82
GM	0.23	1.4	0.64	4500	
GM	0.23	1.4	0.64	4500	

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GM	0.21	1.3	0.66	4500		1.9
GM	0.2	1.3	0.24	3000		
GM	0.091	1.3	0.69	4000		0.73
GM	0.21	1.3	0.66	4500		
GM	0.16	1.2	0.4	2500		
GM	0.2	1.2	0.12	2750		1.2
GM	0.13	1.2	0.85	4000		
GM	0.2	1.2	0.69	3875		1.2
GM	0.12	1.2	0.43	3625		
GM	0.12	1.1	0.48	3750		
GM	0.14	0.99	0.31	3000		
GM	0.18	0.97	0.61	3750		1.2
GM	0.14	0.94	0.58	3625		
GM	0.2	0.94	0.74	3750		1.2
GM	0.12	0.93	0.31	3000		
GM	0.2	0.91	0.36	3750		
GM	0.19	0.86	0.64	3750		
GM	0.1	0.85	0.55	3625		
GM	0.13	0.85	0.88	4000		0.83
GM	0.28	0.7	0.66	2625	0.24	
GM	0.13	0.67	0.41	3750		0.63
GM	0.19	0.6	0.61	2500		
GM	0.14	0.52	0.46	2500		1.4
GM	0.17	0.5	0.54	2500		1.3
Honda	0.24	3.2	0.59	2250		
Honda	0.23	3.1	0.37	2875		
Honda	0.23	3	0.56	2000		
Honda	0.2	2.7	0.58	2000		
Honda	0.18	2.6	0.22	2375		0.93
Honda	0.22	2.6	0.59	2000		
Honda	0.23	2.6	0.42	2375		
Honda	0.22	2.5	0.32	2375		
Honda	0.26	2.4	0.56	2250		
Honda	0.19	2.4	0.5	2000		
Honda	0.18	2.3	0.22	2625		
Honda	0.25	2.3	0.27	2750		
Honda	0.19	2.2	0.34	2625		
Honda	0.19	2.2	0.5	2625		
Honda	0.2	2.2	0.53	2875		0.66
Honda	0.23	2	0.66	2875		
Honda	0.27	1.8	0.28	2750		
Honda	0.13	1.8	0.3	2375		
Honda	0.24	1.8	0.79	2250		
Honda	0.16	1.6	0.72	2500		
Honda	0.2	1.6	0.26	2875		
Honda	0.15	1.5	0.37	2375		1.7
Honda	0.18	1.5	0.61	2625		
Honda	0.19	1.4	0.22	2750		0.45
Honda	0.21	1.4	0.55	2750		
Honda	0.21	1.4	0.52	2875		
Honda	0.17	1.2	0.63	2875		
Honda	0.17	1.2	0.64	2875		
Honda	0.17	1.1	0.47	2875		
Honda	0.13	1.1	0.71	2375		
Honda	0.13	1	0.83	2000		
Honda	0.12	0.8	0.75	2000		

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Honda	0.097	0.68	0.39	2625	
Isuzu	0.18	3.2	0.26	3250	0.46
Isuzu	0.18	3.2	0.26	3250	0.45
Isuzu	0.3	2.4	0.27	3000	0.22
Isuzu	0.3	2.4	0.27	3000	0.23
Isuzu	0.29	2.3	0.29	3000	
Isuzu	0.29	2.3	0.29	3000	
Isuzu	0.15	2.1	0.4	3250	0.47
Isuzu	0.11	1.7	0.31	3250	
Isuzu	0.11	1.7	0.31	3250	
Isuzu	0.11	1.6	0.39	3250	
Isuzu	0.09	0.98	0.49	2250	1.2
Isuzu	0.09	0.98	0.49	2250	1.2
Isuzu	0.09	0.98	0.49	2250	1.2
Isuzu	0.09	0.98	0.49	2250	1.2
Isuzu	0.085	0.84	0.45	2250	
Isuzu	0.085	0.84	0.45	2250	1
Isuzu	0.085	0.84	0.45	2250	
Isuzu	0.085	0.84	0.45	2250	
Jaguar	0.15	2.2	0.33	4250	
Jaguar	0.15	2.2	0.33	4250	
Jaguar	0.18	1.6	0.33	4250	1.4
Jaguar	0.18	1.6	0.33	4250	1.4
Jaguar	0.24	1	0.25	4250	
Jaguar	0.23	1	0.25	4250	
Lotus	0.32	2.2	0.24	3000	1.2
Lotus	0.34	2.2	0.24	3000	0.65
Maserati	0.25	2.9	0.45	3000	1
Maserati	0.23	2.9	0.45	3000	1.5
Maserati	0.13	2	0.43	3000	1
Maserati	0.14	2	0.43	3000	0.52
Mazda	0.24	2.1	0.36	2875	
Mazda	0.21	2.1	0.36	2875	
Mazda	0.16	2	0.35	2875	1.2
Mazda	0.2	2	0.35	2875	0.98
Mazda	0.22	1.9	0.49	3000	0.96
Mazda	0.12	1.7	0.22	2500	0.57
Mazda	0.17	1.7	0.44	2875	
Mazda	0.21	1.6	0.38	3000	
Mazda	0.17	1.5	0.48	2875	
Mazda	0.21	1.5	0.28	2500	
Mazda	0.15	1.4	0.45	2500	1.1
Mazda	0.16	1.4	0.57	2875	
Mazda	0.14	1.2	0.44	2500	
Mazda	0.088	0.65	0.24	2875	
Mazda	0.074	0.65	0.24	2875	
Mazda	0.1	0.31	0.44	2875	
Mazda	0.064	0.25	0.47	3000	0.6
Mercedes	0.31	2.4	0.13	3125	
Mercedes	0.31	2.4	0.13	3125	
Mercedes	0.23	2.3	0.23	3625	
Mercedes	0.23	2.3	0.23	3625	
Mercedes	0.24	2.2	0.16	3375	
Mercedes	0.27	2.2	0.14	4250	
Mercedes	0.24	2.2	0.16	3375	
Mercedes	0.27	2.2	0.14	4250	

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Mercedes	0.21	2.1	0.34	3625		
Mercedes	0.21	2.1	0.34	3625		
Mercedes	0.26	1.7	0.16	4000		
Mercedes	0.26	1.7	0.16	4000		
Mercedes	0.34	1.5	0.26	3375		
Mercedes	0.34	1.5	0.26	3375		
Mercedes	0.16	1.4	0.15	3125		
Mercedes	0.16	1.4	0.15	3125		
Mercedes	0.15	1.2	0.2	4500		0.42
Mercedes	0.15	1.2	0.2	4500		0.42
Mercedes	0.14	1	0.88	3250	0.2	
Mercedes	0.15	0.98	0.78	4250	0.042	
Mercedes	0.25	0.86	0.86	4250	0.34	
Mercedes	0.13	0.83	0.76	3750	0.071	
Mercedes	0.17	0.78	0.8	3750	0.29	
Mercedes	0.093	0.74	0.9	3250	0.21	
Mitsubish	0.23	2.8	0.47	3000		1.6
Mitsubish	0.12	2.5	0.49	3375		1.2
Mitsubish	0.18	2.5	0.46	2625		
Mitsubish	0.12	2.5	0.49	3375		1.2
Mitsubish	0.18	2.5	0.46	2625		
Mitsubish	0.16	2	0.31	3250		
Mitsubish	0.16	2	0.31	3250		
Mitsubish	0.18	2	0.64	2500		1.3
Mitsubish	0.25	1.9	0.31	2875		
Mitsubish	0.25	1.9	0.31	2875		
Mitsubish	0.2	1.9	0.27	3250		
Mitsubish	0.22	1.9	0.3	2875		
Mitsubish	0.13	1.6	0.48	2375		
Mitsubish	0.19	1.3	0.48	2875		
Mitsubish	0.16	1.3	0.47	2875		
Mitsubish	0.19	1.3	0.48	2875		
Mitsubish	0.095	1.2	0.65	3000		
Mitsubish	0.21	1.1	0.47	2375		
Mitsubish	0.18	0.63	0.44	2500		
Mitsubish	0.18	0.63	0.44	2500		
New Unite	0.18	1.6	0.45	2625		
New Unite	0.23	1.1	0.6	2625		0.81
Nissan	0.16	4	0.43	2375		
Nissan	0.21	2.7	0.15	3125		
Nissan	0.14	2.4	0.38	2375		
Nissan	0.18	2.4	0.71	2625		
Nissan	0.21	2.3	0.57	3625		
Nissan	0.16	2.2	0.43	2625		
Nissan	0.16	2.2	0.12	3125		
Nissan	0.24	2.1	0.46	3625		
Nissan	0.2	2	0.35	3500		
Nissan	0.24	1.9	0.48	3625		
Nissan	0.14	1.9	0.34	2750		
Nissan	0.13	1.9	0.12	3125		
Nissan	0.11	1.8	0.17	3375		
Nissan	0.14	1.8	0.35	3375		
Nissan	0.18	1.8	0.38	3625		
Nissan	0.27	1.8	0.64	3625		0.71
Nissan	0.21	1.8	0.13	3125		
Nissan	0.18	1.7	0.2	3125		0.6

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Nissan	0.19	1.7	0.48	3625		0.97
Nissan	0.22	1.7	0.71	3125		
Nissan	0.18	1.7	0.32	3500		
Nissan	0.12	1.6	0.33	3375		
Nissan	0.21	1.6	0.6	3625		
Nissan	0.15	1.5	0.56	2750		1.5
Nissan	0.13	1.6	0.32	3125		
Nissan	0.23	1.5	0.54	3125		
Nissan	0.15	1.4	0.28	3625		
Nissan	0.21	1.3	0.49	3625		1
Nissan	0.15	1.3	0.56	3375		
Nissan	0.12	1.2	0.57	2375		0.34
Nissan	0.19	1.2	0.31	3125		
Nissan	0.16	1.1	0.28	3125		
Nissan	0.085	1	0.7	2375		1.5
Nissan	0.15	0.9	0.39	3125		
Nissan	0.12	0.81	0.83	2375	0.19	
Nissan	0.09	0.77	0.79	2375	0.2	
Nissan	0.088	0.7	0.77	2375		
Panther	0.1	0.46	0.41	2625		1.8
Panther	0.054	0.46	0.41	2625		1.8
Peugeot	0.17	2.7	0.18	3375		0.55
Peugeot	0.17	2.7	0.18	3375		0.69
Peugeot	0.21	2.6	0.17	3375		0.69
Peugeot	0.17	2.6	0.13	3375		0.58
Peugeot	0.21	2.6	0.17	3375		0.83
Peugeot	0.17	2.6	0.13	3375		0.72
Peugeot	0.21	2.5	0.22	3375		0.75
Peugeot	0.21	2.5	0.22	3375		0.89
Peugeot	0.15	2.4	0.16	3375		0.62
Peugeot	0.17	2.4	0.16	3375		0.62
Peugeot	0.14	2.4	0.089	3375		0.55
Peugeot	0.13	2.4	0.089	3375		0.55
Peugeot	0.14	1.9	0.27	3625		1.4
Peugeot	0.15	1.9	0.27	3625		1.4
Peugeot	0.2	1.8	0.11	3500		1.2
Peugeot	0.2	1.8	0.11	3500		1
Peugeot	0.14	1.6	0.075	3500		0.8
Peugeot	0.14	1.6	0.075	3500		0.66
Peugeot	0.4	1.3	0.83	3750	0.33	
Peugeot	0.23	1.3	0.89	3500	0.16	
Peugeot	0.28	1.1	0.85	3500	0.24	
Peugeot	0.19	1	0.096	3500		1
Peugeot	0.19	1	0.096	3500		0.87
Peugeot	0.18	0.97	0.79	3500	0.38	
Porsche	0.25	2.7	0.35	3125		
Porsche	0.31	2.5	0.19	3125		
Porsche	0.31	2.5	0.19	3125		
Porsche	0.32	2.3	0.58	3750		
Porsche	0.23	2.3	0.22	3000		1.7
Porsche	0.25	2.3	0.22	3000		1.2
Porsche	0.29	2.3	0.58	3750		
Porsche	0.27	2.2	0.28	3250		1.2
Porsche	0.29	2.2	0.28	3250		0.71
Porsche	0.23	2.1	0.37	3250		1.8
Porsche	0.26	2.1	0.42	3125		

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Porsche	0.25	2.1	0.37	3250	1.2
Porsche	0.28	1.9	0.54	3250	
Porsche	0.26	1.8	0.36	3500	
Porsche	0.24	1.8	0.36	3500	
Porsche	0.23	1.7	0.34	3125	
Porsche	0.23	1.7	0.34	3125	
Porsche	0.21	1.5	0.16	3125	
Porsche	0.23	1.5	0.16	3125	
Porsche	0.25	1.3	0.33	3125	
Porsche	0.32	1.3	0.46	3000	
Renault	0.24	2.5	0.35	2875	
Renault	0.22	2.3	0.25	2875	
Renault	0.2	2	0.19	2875	
Renault	0.25	2	0.29	2875	
Renault	0.22	1.8	0.29	2875	
Renault	0.17	1.9	0.19	2875	
Renault	0.14	1.4	0.21	2875	1.8
Renault	0.12	1.3	0.21	2875	1.9
Rolls Roy	0.31	2.1	0.61	5500	1.2
Saab	0.25	3.2	0.15	3375	
Saab	0.25	3.2	0.15	3375	
Saab	0.24	2.4	0.22	3250	
Saab	0.24	2.4	0.22	3250	1.4
Saab	0.23	1.9	0.31	3125	
Saab	0.25	1.9	0.29	3125	
Saab	0.23	1.9	0.31	3125	
Saab	0.25	1.9	0.29	3125	
Saab	0.16	1.6	0.23	3125	
Saab	0.16	1.6	0.23	3125	
Saab	0.17	1.3	0.38	3000	
Saab	0.17	1.3	0.38	3000	
Saab	0.15	1.2	0.22	3125	
Saab	0.16	1.2	0.22	3125	
Saab	0.21	0.99	0.62	3250	1.2
Saab	0.21	0.99	0.63	3250	1.2
Suzuki	0.2	1.5	0.14	1750	
Suzuki	0.2	1.5	0.14	1750	0
Suzuki	0.11	1.2	0.18	1875	
Suzuki	0.11	1.2	0.18	1875	
Suzuki	0.082	0.56	0.23	1875	
Suzuki	0.082	0.56	0.23	1875	
Toyota	0.21	2.3	0.29	2625	
Toyota	0.23	2	0.23	3125	
Toyota	0.16	1.9	0.23	3625	0.28
Toyota	0.2	1.9	0.23	3625	0.28
Toyota	0.26	1.9	0.23	3625	0.41
Toyota	0.22	1.9	0.23	3625	0.41
Toyota	0.19	1.7	0.26	3000	
Toyota	0.25	1.7	0.62	2625	1
Toyota	0.16	1.7	0.25	3000	
Toyota	0.16	1.7	0.42	2750	0.23
Toyota	0.18	1.7	0.52	2750	0.21
Toyota	0.17	1.6	0.34	3625	0.24
Toyota	0.19	1.6	0.34	3625	0.24
Toyota	0.13	1.5	0.23	2875	0.26
Toyota	0.19	1.5	0.31	3625	0.28

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Toyota	0.2	1.5	0.32	2750		
Toyota	0.14	1.5	0.23	2875		0.24
Toyota	0.17	1.5	0.31	3625		0.28
Toyota	0.18	1.5	0.26	2750		
Toyota	0.18	1.4	0.24	2750		
Toyota	0.2	1.4	0.3	2750		
Toyota	0.22	1.3	0.33	3125		0.31
Toyota	0.16	1.3	0.25	2875		
Toyota	0.18	1.3	0.26	2875		
Toyota	0.18	1.2	0.28	3000		
Toyota	0.16	1.2	0.28	3000		
Toyota	0.18	0.92	0.75	3000	0.26	
Toyota	0.16	0.89	0.77	2875	0.31	
Toyota	0.12	0.6	0.79	3250	0.18	
Toyota	0.097	0.5	0.82	3250	0.12	
Volkswago	0.24	2.4	0.12	2875		0.8
Volkswago	0.24	2.4	0.13	2875		0.8
Volkswago	0.22	2.3	0.35	2750		
Volkswago	0.22	2.3	0.35	2750		
Volkswago	0.37	2.2	0.14	2625		
Volkswago	0.16	2.2	0.27	2875		
Volkswago	0.37	2.2	0.14	2625		
Volkswago	0.16	2.2	0.29	2875		
Volkswago	0.19	2	0.13	2875		
Volkswago	0.33	2	0.21	2625		
Volkswago	0.21	2	0.37	2875		
Volkswago	0.21	2	0.37	2875		
Volkswago	0.35	2	0.2	2625		
Volkswago	0.19	2	0.14	2875		
Volkswago	0.35	2	0.2	2625		
Volkswago	0.33	2	0.21	2625		
Volkswago	0.28	1.9	0.2	2625		
Volkswago	0.2	1.9	0.3	2750		1.5
Volkswago	0.2	1.9	0.3	2750		1.5
Volkswago	0.28	1.9	0.2	2625		
Volkswago	0.25	1.7	0.076	2625		
Volkswago	0.25	1.7	0.076	2625		
Volkswago	0.14	1.7	0.25	2625		
Volkswago	0.2	1.5	0.42	2625		
Volkswago	0.12	1.5	0.11	2625		
Volkswago	0.21	1.5	0.52	2625		
Volkswago	0.12	1.5	0.11	2625		
Volkswago	0.21	1.5	0.52	2625		
Volkswago	0.2	1.5	0.42	2625		
Volkswago	0.18	1.4	0.33	2625		0.77
Volkswago	0.18	1.4	0.33	2625		0.75
Volkswago	0.2	1.3	0.076	2625		
Volkswago	0.2	1.3	0.076	2625		
Volkswago	0.18	1	0.16	2750		
Volkswago	0.18	1	0.16	2750		
Volkswago	0.41	1	0.84	2625	0.19	
Volkswago	0.26	0.87	0.77	2625	0.13	
Volkswago	0.21	0.81	0.87	2625	0.18	
Volvo	0.32	2.4	0.1	3375		1.1
Volvo	0.21	1.9	0.58	3375		
Volvo	0.22	1.9	0.073	3500		

Automobiles 86 Certification Data - Preliminary

Volvo	0.3	1.7	0.85	3500	0.35		
Volvo	0.22	1.6	0.094	3375			
volvo	0.23	1.4	0.26	3250			
Volvo	0.23	1.4	0.26	3250			
Volvo	0.23	1.4	0.26	3250			
volvo	0.23	1.4	0.26	3250			
Volvo	0.19	1.3	0.21	3250			
volvo	0.19	1.3	0.21	3250			
Volvo	0.19	1.3	0.21	3250			
volvo	0.19	1.3	0.21	3250			
Volvo	0.18	1.2	0.95	3500	0.3		
volvo	0.13	0.73	0.18	3375			
volvo	0.13	0.73	0.18	3375			
Volvo	0.13	0.73	0.18	3375			
Volvo	0.13	0.73	0.18	3375			
Yugo Amer	0.3	2.8	0.73	2125		1.9	
count	574	574	574	574	31	197	7
Avg.	0.201386	1.874459	0.393538	3112.134	0.183	0.963654	0.571428
Min	0	0.16	0.073	1750	0	0	0
Max	0.41	6.1	0.99	5500	0.38	2	1

ATTACHMENT 2

110m16.66M

1986 Certification Distribution - Cars

HC	CO	NOx	percent below	Particles	percent below
0.41	6.1	0.99	1.00	0.38	0.96
0.41	5.4	0.95	1.00	0.36	0.92
0.4	5.1	0.92	0.99	0.35	0.88
0.37	5	0.91	0.99	0.34	0.84
0.37	5	0.91	0.99	0.33	0.8
0.37	4.9	0.91	0.99	0.31	0.76
0.36	4.5	0.9	0.99	0.3	0.72
0.36	4.2	0.89	0.99	0.29	0.68
0.35	4.2	0.88	0.98	0.26	0.64
0.35	4	0.88	0.98	0.24	0.6
0.35	4	0.87	0.98	0.24	0.56
0.35	3.9	0.87	0.98	0.21	0.52
0.35	3.7	0.86	0.98	0.21	0.48
0.35	3.7	0.86	0.98	0.2	0.44
0.35	3.7	0.86	0.97	0.2	0.4
0.34	3.6	0.85	0.97	0.2	0.36
0.34	3.4	0.85	0.97	0.19	0.32
0.34	3.4	0.85	0.97	0.18	0.28
0.34	3.4	0.85	0.97	0.18	0.24
0.33	3.3	0.84	0.97	0.18	0.2
0.33	3.3	0.83	0.96	0.16	0.16
0.33	3.2	0.83	0.96	0.13	0.12
0.33	3.2	0.83	0.96	0.12	0.08
0.33	3.2	0.82	0.96	0.071	0.04
0.33	3.2	0.81	0.96	0.042	-3.2E-16
0.33	3.2	0.8	0.95		
0.33	3.2	0.79	0.95		
0.33	3.2	0.79	0.95		
0.32	3.2	0.79	0.95		
0.32	3.2	0.79	0.95		
0.32	3.2	0.79	0.95		
0.32	3.2	0.78	0.94		
0.32	3.1	0.77	0.94		
0.32	3.1	0.77	0.94		
0.32	3.1	0.76	0.94		
0.32	3.1	0.76	0.94		
0.31	3.1	0.75	0.94		
0.31	3.1	0.75	0.93		
0.31	3	0.74	0.93		
0.31	3	0.73	0.93		
0.31	3	0.73	0.93		
0.31	2.9	0.73	0.93		
0.31	2.9	0.73	0.93		
0.31	2.9	0.72	0.92		
0.31	2.9	0.72	0.92		
0.3	2.9	0.71	0.92		
0.3	2.9	0.71	0.92		
0.3	2.9	0.71	0.92		
0.3	2.9	0.71	0.91		
0.3	2.9	0.7	0.91		
0.3	2.9	0.69	0.91		
0.3	2.8	0.69	0.91		
0.3	2.8	0.68	0.91		
0.29	2.8	0.68	0.91		

1986 Certification Distribution - Cars

0.29	2.8	0.68	0.90
0.29	2.8	0.66	0.90
0.29	2.8	0.66	0.90
0.29	2.8	0.66	0.90
0.29	2.8	0.66	0.90
0.29	2.8	0.66	0.90
0.29	2.8	0.66	0.89
0.29	2.8	0.66	0.89
0.29	2.8	0.65	0.89
0.28	2.8	0.65	0.89
0.28	2.8	0.65	0.89
0.28	2.8	0.65	0.89
0.28	2.8	0.64	0.88
0.28	2.7	0.64	0.88
0.28	2.7	0.64	0.88
0.28	2.7	0.64	0.88
0.28	2.7	0.64	0.88
0.28	2.7	0.64	0.87
0.28	2.7	0.64	0.87
0.28	2.7	0.63	0.87
0.28	2.7	0.63	0.87
0.28	2.7	0.63	0.87
0.28	2.7	0.63	0.87
0.27	2.7	0.63	0.86
0.27	2.7	0.62	0.86
0.27	2.7	0.62	0.86
0.27	2.6	0.62	0.86
0.27	2.6	0.62	0.86
0.27	2.6	0.62	0.86
0.27	2.6	0.61	0.85
0.27	2.6	0.61	0.85
0.26	2.6	0.61	0.85
0.26	2.6	0.61	0.85
0.26	2.6	0.61	0.85
0.26	2.6	0.61	0.84
0.26	2.6	0.6	0.84
0.26	2.5	0.6	0.84
0.26	2.5	0.59	0.84
0.26	2.5	0.59	0.84
0.26	2.5	0.59	0.84
0.26	2.5	0.59	0.83
0.26	2.5	0.58	0.83
0.26	2.5	0.58	0.83
0.26	2.5	0.58	0.83
0.26	2.5	0.58	0.83
0.26	2.5	0.58	0.83
0.25	2.5	0.58	0.82
0.25	2.5	0.58	0.82
0.25	2.5	0.58	0.82
0.25	2.5	0.57	0.82
0.25	2.5	0.57	0.82
0.25	2.5	0.57	0.82
0.25	2.5	0.57	0.81
0.25	2.5	0.57	0.81
0.25	2.5	0.56	0.81
0.25	2.5	0.56	0.81

1986 Certification Distribution - Cars

0.25	2.5	0.56	0.81
0.25	2.5	0.56	0.80
0.25	2.4	0.56	0.80
0.25	2.4	0.56	0.80
0.25	2.4	0.55	0.80
0.25	2.4	0.55	0.80
0.25	2.4	0.55	0.80
0.25	2.4	0.55	0.79
0.25	2.4	0.54	0.79
0.25	2.4	0.54	0.79
0.25	2.4	0.54	0.79
0.25	2.4	0.54	0.79
0.25	2.4	0.54	0.79
0.25	2.4	0.53	0.78
0.25	2.4	0.53	0.78
0.25	2.4	0.53	0.78
0.25	2.4	0.53	0.78
0.25	2.4	0.53	0.78
0.24	2.4	0.52	0.78
0.24	2.4	0.52	0.77
0.24	2.3	0.52	0.77
0.24	2.3	0.52	0.77
0.24	2.3	0.52	0.77
0.24	2.3	0.52	0.77
0.24	2.3	0.52	0.76
0.24	2.3	0.52	0.76
0.24	2.3	0.52	0.76
0.24	2.3	0.52	0.76
0.24	2.3	0.52	0.76
0.24	2.3	0.51	0.76
0.24	2.3	0.51	0.75
0.24	2.3	0.51	0.75
0.24	2.3	0.51	0.75
0.24	2.3	0.51	0.75
0.24	2.3	0.51	0.75
0.24	2.3	0.5	0.75
0.24	2.3	0.5	0.74
0.24	2.3	0.5	0.74
0.24	2.3	0.5	0.74
0.24	2.3	0.5	0.74
0.24	2.3	0.5	0.74
0.24	2.3	0.5	0.74
0.24	2.3	0.5	0.73
0.24	2.3	0.49	0.73
0.24	2.3	0.49	0.73
0.24	2.3	0.49	0.73
0.24	2.3	0.49	0.73
0.24	2.3	0.49	0.72
0.24	2.3	0.49	0.72
0.24	2.3	0.49	0.72
0.23	2.3	0.49	0.72
0.23	2.3	0.49	0.72
0.23	2.2	0.49	0.72
0.23	2.2	0.49	0.71
0.23	2.2	0.48	0.71
0.23	2.2	0.48	0.71

1986 Certification Distribution - Cars

0.23	2.2	0.48	0.71
0.23	2.2	0.48	0.71
0.23	2.2	0.48	0.71
0.23	2.2	0.48	0.70
0.23	2.2	0.48	0.70
0.23	2.2	0.48	0.70
0.23	2.2	0.48	0.70
0.23	2.2	0.48	0.70
0.23	2.2	0.48	0.70
0.23	2.2	0.48	0.69
0.23	2.2	0.48	0.69
0.23	2.2	0.47	0.69
0.23	2.2	0.47	0.69
0.23	2.2	0.47	0.69
0.23	2.2	0.47	0.68
0.23	2.2	0.47	0.68
0.23	2.2	0.47	0.68
0.23	2.2	0.47	0.68
0.23	2.2	0.46	0.68
0.23	2.2	0.46	0.68
0.23	2.2	0.46	0.67
0.23	2.2	0.46	0.67
0.23	2.2	0.46	0.67
0.23	2.1	0.46	0.67
0.23	2.1	0.46	0.67
0.23	2.1	0.46	0.67
0.23	2.1	0.46	0.66
0.23	2.1	0.46	0.66
0.23	2.1	0.46	0.66
0.23	2.1	0.46	0.66
0.23	2.1	0.46	0.66
0.23	2.1	0.46	0.66
0.23	2.1	0.45	0.65
0.22	2.1	0.45	0.65
0.22	2.1	0.45	0.65
0.22	2.1	0.45	0.65
0.22	2.1	0.45	0.65
0.22	2.1	0.45	0.64
0.22	2.1	0.45	0.64
0.22	2.1	0.45	0.64
0.22	2	0.45	0.64
0.22	2	0.45	0.64
0.22	2	0.45	0.64
0.22	2	0.45	0.63
0.22	2	0.45	0.63
0.22	2	0.45	0.63
0.22	2	0.44	0.63
0.22	2	0.44	0.63
0.22	2	0.44	0.63
0.22	2	0.44	0.62
0.22	2	0.44	0.62
0.22	2	0.44	0.62
0.22	2	0.44	0.62
0.22	2	0.44	0.62
0.22	2	0.44	0.61
0.22	2	0.44	0.61

1986 Certification Distribution - Cars

0.21	2	0.43	0.61
0.21	2	0.43	0.61
0.21	2	0.43	0.61
0.21	2	0.43	0.61
0.21	2	0.43	0.60
0.21	2	0.43	0.60
0.21	2	0.43	0.60
0.21	2	0.43	0.60
0.21	2	0.42	0.60
0.21	2	0.42	0.60
0.21	2	0.42	0.59
0.21	2	0.42	0.59
0.21	2	0.42	0.59
0.21	2	0.42	0.59
0.21	2	0.42	0.59
0.21	2	0.41	0.59
0.21	1.9	0.41	0.58
0.21	1.9	0.41	0.58
0.21	1.9	0.41	0.58
0.21	1.9	0.41	0.58
0.21	1.9	0.41	0.58
0.21	1.9	0.41	0.57
0.21	1.9	0.41	0.57
0.21	1.9	0.41	0.57
0.21	1.9	0.41	0.57
0.21	1.9	0.4	0.57
0.21	1.9	0.4	0.57
0.21	1.9	0.4	0.56
0.21	1.9	0.4	0.56
0.21	1.9	0.4	0.56
0.21	1.9	0.4	0.56
0.21	1.9	0.4	0.56
0.21	1.9	0.39	0.56
0.21	1.9	0.39	0.55
0.21	1.9	0.39	0.55
0.21	1.9	0.39	0.55
0.21	1.9	0.39	0.55
0.21	1.9	0.38	0.55
0.21	1.9	0.38	0.55
0.2	1.9	0.38	0.54
0.2	1.9	0.38	0.54
0.2	1.9	0.38	0.54
0.2	1.9	0.38	0.54
0.2	1.9	0.38	0.54
0.2	1.9	0.38	0.53
0.2	1.9	0.38	0.53
0.2	1.9	0.38	0.53
0.2	1.9	0.37	0.53
0.2	1.9	0.37	0.53
0.2	1.9	0.37	0.53
0.2	1.9	0.37	0.52
0.2	1.9	0.37	0.52
0.2	1.8	0.37	0.52
0.2	1.8	0.37	0.52
0.2	1.8	0.37	0.52
0.2	1.8	0.37	0.52

1986 Certification Distribution - Cars

0.2	1.8	0.37	0.51
0.2	1.8	0.36	0.51
0.2	1.8	0.36	0.51
0.2	1.8	0.36	0.51
0.2	1.8	0.36	0.51
0.2	1.8	0.36	0.51
0.2	1.8	0.36	0.50
0.2	1.8	0.36	0.50
0.2	1.8	0.36	0.50
0.2	1.8	0.36	0.50
0.2	1.8	0.36	0.50
0.2	1.8	0.36	0.49
0.2	1.8	0.36	0.49
0.2	1.8	0.36	0.49
0.2	1.8	0.35	0.49
0.2	1.8	0.35	0.49
0.2	1.8	0.35	0.49
0.19	1.8	0.35	0.48
0.19	1.8	0.35	0.48
0.19	1.8	0.35	0.48
0.19	1.8	0.35	0.48
0.19	1.8	0.35	0.48
0.19	1.8	0.35	0.48
0.19	1.8	0.35	0.47
0.19	1.8	0.34	0.47
0.19	1.7	0.34	0.47
0.19	1.7	0.34	0.47
0.19	1.7	0.34	0.47
0.19	1.7	0.34	0.47
0.19	1.7	0.34	0.46
0.19	1.7	0.34	0.46
0.19	1.7	0.34	0.46
0.19	1.7	0.34	0.46
0.19	1.7	0.34	0.46
0.19	1.7	0.34	0.45
0.19	1.7	0.33	0.45
0.19	1.7	0.33	0.45
0.19	1.7	0.33	0.45
0.19	1.7	0.33	0.45
0.19	1.7	0.33	0.45
0.19	1.7	0.33	0.44
0.19	1.7	0.33	0.44
0.19	1.7	0.33	0.44
0.19	1.7	0.33	0.44
0.19	1.7	0.33	0.44
0.19	1.7	0.33	0.44
0.19	1.7	0.33	0.43
0.18	1.7	0.32	0.43
0.18	1.7	0.32	0.43
0.18	1.7	0.32	0.43
0.18	1.7	0.32	0.43
0.18	1.7	0.32	0.43
0.18	1.7	0.32	0.42
0.18	1.7	0.32	0.42
0.18	1.7	0.32	0.42
0.18	1.7	0.31	0.42

1986 Certification Distribution - Cars

0.18	1.6	0.31	0.42
0.18	1.6	0.31	0.41
0.18	1.6	0.31	0.41
0.18	1.6	0.31	0.41
0.18	1.6	0.31	0.41
0.18	1.6	0.31	0.41
0.18	1.6	0.31	0.41
0.18	1.6	0.31	0.40
0.18	1.6	0.31	0.40
0.18	1.6	0.31	0.40
0.18	1.6	0.31	0.40
0.18	1.6	0.31	0.40
0.18	1.6	0.31	0.40
0.18	1.6	0.31	0.39
0.18	1.6	0.3	0.39
0.18	1.6	0.3	0.39
0.18	1.6	0.3	0.39
0.18	1.6	0.3	0.39
0.18	1.6	0.3	0.39
0.18	1.6	0.3	0.38
0.18	1.6	0.3	0.38
0.18	1.6	0.3	0.38
0.18	1.6	0.3	0.38
0.18	1.6	0.29	0.38
0.18	1.6	0.29	0.37
0.18	1.6	0.29	0.37
0.18	1.6	0.29	0.37
0.18	1.6	0.29	0.37
0.17	1.6	0.29	0.37
0.17	1.5	0.29	0.37
0.17	1.5	0.29	0.36
0.17	1.5	0.29	0.36
0.17	1.5	0.29	0.36
0.17	1.5	0.29	0.36
0.17	1.5	0.29	0.36
0.17	1.5	0.29	0.36
0.17	1.5	0.28	0.35
0.17	1.5	0.28	0.35
0.17	1.5	0.28	0.35
0.17	1.5	0.28	0.35
0.17	1.5	0.28	0.35
0.17	1.5	0.28	0.34
0.17	1.5	0.28	0.34
0.17	1.5	0.28	0.34
0.17	1.5	0.28	0.34
0.17	1.5	0.28	0.34
0.17	1.5	0.28	0.34
0.17	1.5	0.28	0.33
0.17	1.5	0.28	0.33
0.17	1.5	0.28	0.33
0.17	1.5	0.27	0.33
0.17	1.5	0.27	0.33
0.17	1.5	0.27	0.33
0.17	1.5	0.27	0.32
0.17	1.5	0.27	0.32
0.17	1.5	0.27	0.32

1986 Certification Distribution - Cars

0.17	1.5	0.27	0.32
0.17	1.5	0.27	0.32
0.17	1.5	0.27	0.32
0.17	1.5	0.27	0.31
0.17	1.5	0.27	0.31
0.17	1.5	0.27	0.31
0.17	1.5	0.26	0.31
0.17	1.5	0.26	0.31
0.16	1.4	0.26	0.30
0.16	1.4	0.26	0.30
0.16	1.4	0.26	0.30
0.16	1.4	0.26	0.30
0.16	1.4	0.26	0.30
0.16	1.4	0.26	0.30
0.16	1.4	0.26	0.29
0.16	1.4	0.26	0.29
0.16	1.4	0.26	0.29
0.16	1.4	0.26	0.29
0.16	1.4	0.26	0.29
0.16	1.4	0.26	0.29
0.16	1.4	0.25	0.28
0.16	1.4	0.25	0.28
0.16	1.4	0.25	0.28
0.16	1.4	0.25	0.28
0.16	1.4	0.25	0.28
0.16	1.4	0.25	0.27
0.16	1.4	0.25	0.27
0.16	1.4	0.25	0.27
0.16	1.4	0.25	0.27
0.16	1.4	0.25	0.27
0.16	1.4	0.25	0.26
0.16	1.4	0.25	0.26
0.16	1.4	0.25	0.26
0.16	1.4	0.25	0.26
0.16	1.4	0.25	0.26
0.16	1.3	0.25	0.25
0.16	1.3	0.25	0.25
0.16	1.3	0.25	0.25
0.16	1.3	0.25	0.25
0.16	1.3	0.25	0.25
0.16	1.3	0.24	0.25
0.16	1.3	0.24	0.24
0.15	1.3	0.24	0.24
0.15	1.3	0.24	0.24
0.15	1.3	0.24	0.24
0.15	1.3	0.24	0.24
0.15	1.3	0.24	0.24
0.15	1.3	0.24	0.23
0.15	1.3	0.24	0.23
0.15	1.3	0.24	0.23
0.15	1.3	0.24	0.23
0.15	1.3	0.24	0.23
0.15	1.3	0.23	0.22
0.15	1.3	0.23	0.22

1986 Certification Distribution - Cars

0.15	1.3	0.23	0.22
0.15	1.3	0.23	0.22
0.15	1.3	0.23	0.22
0.15	1.3	0.23	0.22
0.15	1.3	0.23	0.21
0.15	1.3	0.23	0.21
0.15	1.3	0.23	0.21
0.15	1.3	0.23	0.21
0.14	1.3	0.23	0.21
0.14	1.3	0.23	0.21
0.14	1.3	0.23	0.20
0.14	1.3	0.23	0.20
0.14	1.3	0.23	0.20
0.14	1.3	0.22	0.20
0.14	1.3	0.22	0.20
0.14	1.3	0.22	0.20
0.14	1.3	0.22	0.19
0.14	1.3	0.22	0.19
0.14	1.3	0.22	0.19
0.14	1.2	0.22	0.19
0.14	1.2	0.22	0.19
0.14	1.2	0.22	0.18
0.14	1.2	0.22	0.18
0.14	1.2	0.22	0.18
0.14	1.2	0.22	0.18
0.14	1.2	0.22	0.18
0.14	1.2	0.22	0.18
0.14	1.2	0.21	0.17
0.14	1.2	0.21	0.17
0.14	1.2	0.21	0.17
0.14	1.2	0.21	0.17
0.14	1.2	0.21	0.17
0.14	1.2	0.21	0.17
0.14	1.2	0.21	0.16
0.14	1.2	0.21	0.16
0.14	1.2	0.21	0.16
0.14	1.2	0.2	0.16
0.14	1.2	0.2	0.16
0.14	1.2	0.2	0.16
0.14	1.2	0.2	0.15
0.13	1.1	0.2	0.15
0.13	1.1	0.2	0.15
0.13	1.1	0.2	0.15
0.13	1.1	0.2	0.15
0.13	1.1	0.2	0.14
0.13	1.1	0.2	0.14
0.13	1.1	0.2	0.14
0.13	1.1	0.2	0.14
0.13	1	0.2	0.14
0.13	1	0.2	0.14
0.13	1	0.19	0.13
0.13	1	0.19	0.13
0.13	1	0.19	0.13
0.13	1	0.19	0.13
0.13	1	0.18	0.13
0.13	1	0.18	0.13

1986 Certification Distribution - Cars

0.13	1	0.18	0.12
0.13	1	0.18	0.12
0.13	1	0.18	0.12
0.13	0.99	0.18	0.12
0.13	0.99	0.18	0.12
0.13	0.99	0.18	0.11
0.13	0.98	0.18	0.11
0.12	0.98	0.18	0.11
0.12	0.98	0.17	0.11
0.12	0.98	0.17	0.11
0.12	0.98	0.17	0.11
0.12	0.98	0.17	0.10
0.12	0.98	0.17	0.10
0.12	0.97	0.16	0.10
0.12	0.97	0.16	0.10
0.12	0.94	0.16	0.10
0.12	0.94	0.16	0.10
0.12	0.93	0.16	0.09
0.12	0.92	0.16	0.09
0.12	0.91	0.16	0.09
0.12	0.9	0.16	0.09
0.12	0.89	0.16	0.09
0.12	0.87	0.16	0.09
0.12	0.86	0.16	0.08
0.12	0.86	0.15	0.08
0.12	0.85	0.15	0.08
0.12	0.85	0.15	0.08
0.12	0.84	0.15	0.08
0.12	0.84	0.15	0.07
0.12	0.84	0.15	0.07
0.12	0.84	0.14	0.07
0.12	0.83	0.14	0.07
0.12	0.81	0.14	0.07
0.11	0.81	0.14	0.07
0.11	0.8	0.14	0.06
0.11	0.79	0.14	0.06
0.11	0.78	0.14	0.06
0.11	0.77	0.13	0.06
0.11	0.74	0.13	0.06
0.11	0.73	0.13	0.06
0.11	0.73	0.13	0.05
0.11	0.73	0.13	0.05
0.1	0.73	0.13	0.05
0.1	0.7	0.13	0.05
0.1	0.7	0.12	0.05
0.099	0.68	0.12	0.04
0.099	0.67	0.12	0.04
0.098	0.65	0.12	0.04
0.097	0.65	0.11	0.04
0.097	0.65	0.11	0.04
0.095	0.65	0.11	0.03
0.093	0.63	0.11	0.03
0.091	0.63	0.1	0.03
0.09	0.6	0.1	0.03
0.09	0.6	0.1	0.03
0.09	0.56	0.1	0.03
0.09	0.56	0.1	0.02
0.09	0.55	0.096	0.02
0.088	0.52	0.096	0.02
0.088	0.5	0.094	0.02
0.085	0.5	0.089	0.02
0.085	0.46	0.089	0.02
0.085	0.46	0.079	0.01
0.085	0.4	0.078	0.01
0.085	0.4	0.078	0.01
0.082	0.37	0.076	0.01
0.082	0.31	0.075	0.01
0.074	0.25	0.075	0.01
0.064	0.16	0.073	0.00

Mr. **Robertson**. If I may, sir, to follow up, I did not say it could not be done. I said that it required additional hardware to do it.

Mr. **Waxman**. What hardware would it require?

Mr. **Robertson**. We would have to use heavier catalyst loadings and revised calibrations. If I could, the other point——

Mr. **Waxman**. I am sorry. I have a limited time so let me inquire what I want to pursue here.

Mr. Klimisch, both you and Mr. Robertson have testified that the rhodium necessary to meet these additional NO_x controls is simply not available. First, as I understand, the California Air Resources Board found that there would be an ample supply of rhodium to justify going from a 0.7 grams per mile to 0.4 grams per mile. Second, as I understand it the total worldwide rhodium supply is approximately 72 million troy ounces. The current word rhodium demand is about 225,000 troy ounces with the auto industry requiring about 50 percent of this rhodium.

Given the supply and the very little additional rhodium if any that you will need to certify to standards that you already certify to, can you really say and I quote, "The rhodium necessary to meet the additional vehicle controls in H.R. 4567 is simply not available."

Mr. **Klimisch**. Yes; the problem with this issue and the last one has to do with certification versus in-use requirements and for the durability of our vehicles in terms of emissions——

Mr. **Waxman**. I am talking about supply of rhodium.

Mr. **Klimisch**. Yes; we need more rhodium in the catalyst and in fact, it is going to outstrip the supply very quickly even without these provisions and these provisions will exacerbate that condition.

Mr. **Waxman**. With 72 million troy ounces as the total worldwide supply, how can you say that this additional use of rhodium is going to outstrip the world supply?

Mr. **Klimisch**. Look, we are already using it. It is all used up. There isn't any more available.

Mr. **Waxman**. I submit that we have enough rhodium for 280 years.

Mr. **Klimisch**. Absolutely not true. Your numbers are wrong, sir.

Mr. **Waxman**. Well, sir, this is what the California Air Resources Board relied upon in their decision.

Mr. **Klimisch**. I know and they are wrong as well.

Mr. **Waxman**. But you are going to meet a 0.4 NO_x standard in California or not sell cars there and I suspect you are going to meet that standard, is that true?

Mr. **Klimisch**. Well, we are going to try to sell cars there but that is 10 percent of the fleet. It is another thing to do it for the whole United States.

Mr. **Waxman**. Can you meet the 0.4 standard in California without additional rhodium?

Mr. **Klimisch**. Probably not.

Mr. **Waxman**. Did any of you testify before the California Air Resources Board that you are going to quit selling cars in California rather than meet that 0.4 standard?

Mr. **Klimisch**. No; we are going to try.

Mr. **Sikorski**. Mr. Chairman.

Mr. **Waxman**. I do want to move on, Mr. Sikorski.

Mr. Ritter.

Mr. **Ritter**. Thank you, Mr. Chairman. I would just like to go over this rhodium business a little bit. As a former metallurgist interested in strategic matters, I see a wide gap and I wondered if we could narrow the gap.

The chairman has quoted statistics of rhodium availability that you have flat out denied. Where are your statistics coming from and why is there such an enormous gap?

Mr. **Klimisch**. Well, I think one of the problems has to do with supply. There indeed is rhodium in the ground in South Africa. You have to understand that rhodium is a minor byproduct of platinum production. It occurs in 5 percent of the platinum that you get out.

It is virtually out of the question to begin opening mines for that byproduct. We know it is there but you can't mine for a byproduct. It would just be incredibly expensive.

Mr. **Ritter**. Where is the other major source of platinum in addition to South Africa?

Mr. **Klimisch**. Soviet Union is the only other commercial source.

Mr. **Ritter**. I have another technical point. There have been studies on the relationship between NO_x and ozone and in some cases the reductions of NO_x seem to be related to increases in ozone concentrations.

I think in Southern California there have been some studies that have linked the two. This is not true in all cases though, is it, and what are your views on this?

Mr. **Klimisch**. There are some theoretical studies that say that it is not true in all cases and we have been doing experimental work for some years and in experimental situations where we go out and capture air and add NO_x to it, we find in every case in urban ozone a NO_x decrease will increase ozone.

We have never found an exception to that.

Mr. **Ritter**. This should be of concern as we try to evaluate the scientific base of a further NO_x reduction because ozone may be one of the culprits in the forest deterioration situation.

Mr. **Klimisch**. Yes; that is my understanding. But the problem I am worried about is that not only does it raise ozone but it tends to move the ozone back toward the populated areas.

Mr. **Ritter**. Of course, ozone is a key component in smog. Now California has had for some time an auto-NO_x standard of 0.7 grams per mile and the State has now recently lowered that standard to 0.4 grams per mile. Obviously, they have considered this ozone/NO_x tradeoff and they don't seem to be concerned.

What is the matter with California or what is the matter with your results?

Mr. **Klimisch**. They have had a difficult tradeoff. They have the only NO_2 compliance in the country and until recently at least the NO_2 noncompliance was driving them to reduce NO_x. I think they now agree that this will exacerbate the ozone problem.

But we can't understand why they have taken this recent action because the projections now say that NO_2 will come into compliance and we believe this action will exacerbate ozone which is by far their worst problem there.

Mr. **Ritter**. But what it also shows is that the reductions to 0.7 grams per mile on a nationwide basis are imminently obtainable. They are being accomplished in California and in fact, they are going down to 0.4 grams per mile.

Mr. **Klimisch**. Currently the only provision is that they have more lenient hydrocarbon CO standards and that makes the 0.7 standard they currently have achievable. The next standards that go into effect in 1989 as I said at this point we don't know how we would do. One thing we will have to do is increase the rhodium in those catalysts.

Mr. **Ritter**. Getting back to the rhodium, Mr. Chairman, I would ask unanimous consent that Dr. Klimisch have the opportunity to provide for the record his basis for concluding that the rhodium supply for the catalytic converters to do the job is not going to be available.

Mr. **Waxman**. I think we ought to include that in the record and the report from the California Air Resources Board in concluding that they could meet these tighter standards and contribute to the reduction of ozone in the heavily polluted State of California.

Mr. **Ritter**. Sure.

Mr. **Waxman**. Without objection, that will be the order.

Mr. **Ritter**. I thank the chairman. This is for all panelists. What is the calculation of electricity use charge increase that, collectively, our automobile industry faces as a result of this bill and how meaningful is that use charge increase in your overall activity? Does anyone want to take a shot at that, one of the others?

Mr. **Buist**. Congressman, I am not a stationary source expert. I have dealt with the mobile source piece of it but I am told that——

Mr. **Ritter**. Obviously though the automobile industry uses a fair amount of electricity.

Mr. **Buist**. Yes, we do, and I am told that this bill would impact Ford in the area of an increase of about $24 million per year in powerplant expense.

Mr. **Waxman**. Thank you very much. Mr. Sikorski.

Mr. **Ritter**. Mr. Chairman, if I might just have an additional 30 seconds to complete that. I asked the question and I would just like to get a more cross-sectional answer.

Mr. **Waxman**. Without objection, the gentleman will be granted another additional minute.

Mr. **Ritter**. Does anybody else have any calculations?

Mr. **Klimisch**. Yes. Our cost increase is estimated to be $75 million and that is consistent with Ford. The total industry cost increase of the order of $150 million which works out to something like $25 per car.

Mr. **Ritter**. Now if you combine the electricity use charge with the additional cost of the compliance, what are we talking about for the automobile industry, just to get a realistic view of what is going on?

Mr. **Klimisch**. I think we are looking, I would guess, in the $100 per car overall but I would have to do that more carefully to get some real cost of that.

Mr. **Robertson**. If I may, I have no comment to add on the stationary source part. On the mobile source part, this bill contains such a wide array of different effects on passenger car and truck that I would like to submit that for the record.

Mr. **Ritter**. Mr. Chairman, I ask unanimous consent that these gentlemen be allowed to submit for the record the cost impact of H.R. 4567. [See p. 161.]

Mr. **Waxman**. Without objection, we will look forward to receiving that information for the record.

Mr. **Ritter**. I thank the chairman.

Mr. **Waxman**. Mr. Sikorski.

Mr. **Sikorski**. Thank you, Mr. Chairman. Following up on this rhodium factor, Mr. Klimisch, there is, is there not, a serious and significant effort to developing a high technology catalyst without any additional need for rhodium?

Mr. **Klimisch**. Yes, sir. As we have seen this rhodium scarcity approaching, we have indeed been doing everything we can to try to find catalytic processes or processes that don't use rhodium but we haven't been successful and we don't see that happening.

Mr. **Sikorski**. Which parallels human efforts throughout history, whenever there is a scarcity factor, we come up with substitutes. The one example of the type of development underway was reported in the Society of Automotive Engineers technical paper entitled and I quote, "Effective Rhodium Utilization in Automotive Exhaust Catalysts."

It says in part in there and I quote·

> By designing the Rh function in the catalyst to be more thermally stable and with the prospects of less poisoning from Pb, lead, the Rh or rhodium content of high tech catalysts can be reduced.

You are familiar with that effort?

Mr. **Klimisch**. Yes.

Mr. **Sikorski**. Chrysler, Ford, what is your situation on the rhodium factor?

Mr. **Buist**. It is very similar to Dr. Klimisch. We are all struggling with it. We are all concerned about supply.

Mr. **Sikorski**. I guess more specifically, are you working on this higher tech catalyst?

Mr. **Buist**. Yes, we are. It is like Dr. Klimisch indicated, it is something that is far out into the future. It is not something that can be addressed in the timeframe that this bill addresses.

Mr. **Sikorski**. You get closer in the future in California and that is a 0.4 standard, right?

Mr. **Buist**. With respect to California and 0.4, we testified there last week in support of that bill, basically in support of the bill or the proposal to the California Air Resources Board and the support came from the fact that California is in noncompliance for NO_2, the only area in the United States that is.

When that is obvious to us, then we support further control and that is the problem we are struggling with here with 0.7. The rest of the Nation is in compliance and in fact, well below the national standard.

Mr. **Sikorski**. Mr. Robertson.

Mr. **Robertson**. I just wanted to comment that we don't anticipate single handedly using up the remaining world supply of rhodium. Our major concern with rhodium has to do with the fact that it sells for about $1,000 per ounce so with or without an impending depletion of it, our goal of course is to absolutely minimize it.

Mr. **Sikorski**. The market is very volatile?

Mr. **Robertson**. That's true.

Mr. **Sikorski**. It was $640 earlier and then the $1,000 back and forth.

Mr. **Waxman**. Would the gentleman yield?

Mr. **Sikorski**. Yes.

Mr. **Waxman**. Mr. Buist, I didn't understand that last statement you made. When you recognize there is an environmental danger such as exists in California, you are willing to cooperate and try to meet the standards but if you don't think this is a real contribution to acid rain at the national level, it sounds like you are not willing to cooperate and that is why you testify you can't cooperate. Is that what I am hearing?

Mr. **Buist**. Basically what I said was that we are struggling with a reduction nationwide from one gram of NO_x to 0.7 because EPA tells us that the Nation is in compliance with respect to NO_2.

If it is an NO_2 issue, it doesn't make sense that we should reduce to 0.7. If it is an acid rain issue, then we look at the EPA analysis and it says, Were we to go to 0.7 between now and the year 2000, they might see a 1-percent improvement as a result of passenger cars going to 0.7. In our mind, that also does not make sense.

Mr. **Waxman**. So if we could establish in these congressional hearings that that information is incorrect and that we could get a contribution to the reduction of the acid rain problem by the standards that we have in this legislation, you then feel you would be willing to cooperate and meet those standards.

Mr. **Buist**. If we can be convinced that the air quality is going to benefit as a result of that and benefit significantly, yes.

Mr. **Waxman**. Thank you very much.

Mr. **Sikorski**. Mr. Klimisch, on page 5 of your testimony you state that transportation sources emit very little SO_2 compared to other resources and according to a recent SAE technical paper entitled, "Reducing the Sulfur and Aromatic Content of Diesel Fuel Cost Benefits and Effectiveness for Emission Control" nationwide diesel fuel accounts for about 370,000 tons of SO_2 in 1985 which if taken all together would make it as large as the largest powerplant in the United States.

Again, according to that same study, a 0.05-percent sulfur standard which is being met in southern California would reduce SO_2 by about 285,000 tons per year. That study found that it would be feasible to go even to a 0.03-percent sulfur standard without reducing the availability of diesel fuel and would require little or no addition to the refining capital stock.

The increase in average refining costs due to desulfurization would be about 1.2 cents per gallon and would also improve sustained numbers in ignition quality which would aid cold starting, reduce noise, reduce maintenance by about four times.

It doesn't sound like such a bad deal.

Mr. **Klimisch**. Yes. But I still say of all the fuels we burn, gasoline is certainly virtually the lowest in sulfur and diesel fuel is relatively low compared to coal and things like that but I do not have any disagreement with those things you said.

Mr. **Sikorski.** Thank you, Mr. Chairman.

Mr. **Waxman.** Mr. Whittaker.

Mr. **Whittaker.** Would a member of the panel care to comment on the impact as you see it that the bill might have on light-duty vehicles used on farm use, namely, trucks?

Mr. **Buist.** I would be willing to address that, Mr. Congressman. In our chart over here we tried to explain it. Those are the vehicles that are our primary concern. If you establish NO_x levels at a 1.7 gram level, these are the light end of what EPA calls heavy-duty vehicles or light/heavy-duty vehicles and a large portion of those are represented in the upper right hand corner. They are State truck vehicles that are used in large as well as small farm communities and that is the vehicle that would be significantly impacted if not pushed out of the marketplace.

Mr. **Whittaker.** Thank you. Mr. Chairman, that was my primary area of concern

Mr. **Waxman.** Mr. Scheuer.

Mr. **Scheuer.** Thank you, Mr. Chairman. Gentlemen, I sit here and I hear you coming out against this bill, the purpose of the bill, in a solid phalanx of opposition. It seems to me just one more sort of Pavlovian reaction to any attempt by the Congress to impose new standards of auto efficiency, improve the auto pollution standards, improve the auto in terms of safety, in terms of its theft ability, if you will.

You have told us time and time again that you couldn't do it and when we finally forced you to do it, you did it. One wonders why we have so much more confidence in your technical genius than you seem to have.

For years, you opposed every standard that we imposed on owner safety, whether it was safety glass, the collapsible steering wheel, the directional signals, the soft dashboard. It seems we can count on this as predictably as day following night and winter following fall.

Yet there is some hope because you have set up an environmental health institute headed up by Donald Kennedy and Archibald Cox, two of the most extraordinarily brilliant and talented and credible Americans of our time.

With this arm, your institute which is funded jointly by the industry and by EPA, you are investigating the health effects and presumably also the environmental effects of the industry and I commend you for doing that. I think it is wonderful that you are doing that.

Does this mean that if this institute that you have funded to the extent of 50 percent, you collectively as an industry, comes up with some serious reports as to the health effects of the automobile, you will be prepared to act on those funding?

Without any finger pointing or blame, we have all enjoyed the automobile in the last century. Nobody thought it was going to be degrading of human health. It just turned out that way. So the American public is going to bear the cost of remediating these health effects and these environmental effects because whatever is built in, whatever costs are going to be built into your product, we are going to pay for. The public is going to pay for.

We are going to make sure that foreign importers are going to build in the same health preserving and environment preserving technology so that you will not be under a competitive disadvantage.

Does this mean, in effect, that if your health effects institute, and I commend you again for establishing it comes up with some findings that there are serious health effects and environmental effects of the automobile that have not been treated yet, that you will look at these recommendations seriously and include whatever improved technology or increased application of technology seems to be appropriate for future automobiles as they are designed?

Mr. KLIMISCH. Yes, sir. We certainly will.

Mr. SCHEUER. Any other responses?

Mr. BUIST. Congressman, we committed to that when we joined the Institute.

Mr. SCHEUER. Let me just say again how very much encouraged I feel that you have done that—just created the institute, how very much encouraged I feel that you have selected these two Americans who are hardly with peer or comparison in their integrity, their brilliance, their proven courage under fire and the respect in which they are held by the American public. You could not have picked two finer individuals.

I hope very much that you will follow whatever advice and counsel you get from them and I would hope that you would consult with the scientists that they have retained about this bill to see whether they think the challenge presented by the new standards in this bill can be met feasibly.

In the past your predictions of doom, the little engine that could not turned out to be the little engine that could and maybe they can help you figure out in advance ways that you can do it and can do it on a cost effective basis.

Experience has proven that every time you said you couldn't, you could and you did it intelligently, cost effectively, competently, brilliantly and that is what American industry stands for and you people have been at the vanguard of our industrialized leadership in this world. We hope you are going to continue to lead and progress and maybe these gentlemen will have some counsel for you.

I very much appreciate what you have done and I congratulate you for what you have done in setting up this institute.

Mr. WAXMAN. Thank you, Mr. Scheuer. Mr. Madigan.

Mr. MADIGAN. If I may just pick up, Mr. Chairman, on the remarks of the gentleman from New York, I understood him to say that the Federal Government forced the car manufacturers into a number of things, some of which he named. He named turn signals, deep dish steering wheels, and padded dashboards.

My recollection is that the turn signals were available on General Motors cars in 1940 and 1941. Is that correct?

Mr. KLIMISCH. I am not sure, sir, but some of these safety devices were put on as options. Ultimately, the Federal Government forced those to be applied.

Mr. MADIGAN. The deep dish steering wheel and the padded dashboard that the gentleman from New York referred to was available on Ford automobiles in 1956 before it was required by the Government. Isn't that correct?

Mr. **Buist**. I think you are correct, Congressman, but I am not sure.

Mr. **Madigan**. This is a study published by the Brookings Institution, a reputable organization not noted for their Republican proclivities, entitled, "Regulating the Automobile," the conclusion of which is that the marginal benefits from regulating automobile emissions are exceeded by the marginal cost. Would any of you gentlemen care to comment on this publication and its conclusions or summary? Dr. Klimisch.

Mr. **Klimisch**. Yes. Particularly, if you look at the CO and the NO_2 air quality standards, there is essentially no basis for either of those standards so the benefits are practically nil. So the benefit side is very sparse indeed and if economists go through that calculation, they come to the conclusion that those regulations are certainly not cost effective.

Mr. **Scheuer**. Will my colleague yield briefly?

Mr. **Madigan**. Certainly, not for a soliloquy.

Mr. **Scheuer**. No. I just ask unanimous consent that at this point in the record we insert a letter to the Washington Post by Lee Thomas, the head of the EPA, entitled, "Emissions Control Is Worth the Money." I ask unanimous consent.

Mr. **Waxman**. Without objection.

[Information to be furnished follows:]

Emissions Control Is Worth the Money

In "Cars and Regulation" [editorial, March 26], The Post discussed a recent book published by the Brookings Institution on automobile regulation. While the editorial concedes that emissions regulations have reduced air pollution from cars, it raises the question whether these pollution reductions are cost-effective in protecting human health. If there really is such a question left in people's minds, the answer is an emphatic yes.

The health effects data EPA relies on in setting emission standards are subject to a lengthy public and scientific review. The most recent data on the health effects of ozone, for example, indicate that associated health problems may be more serious than previously thought. Short-term exposures to ozone concentrations very near the standard have been found to impair lung functions in both healthy adults and children. Chronic exposures have been linked to permanent lung damage.

Carbon monoxide can be life-threatening for persons with heart and coronary diseases. Nine percent of the nation's adult population is afflicted with such disease and is potentially sensitive to carbon monoxide; 20 percent of the nation's population has body levels of carbon monoxide above the level that signals the beginning of adverse effects on the heart.

With regard to the cost of protection from such adverse health effects, the Brookings study estimated emission controls to cost $1,600 per car, including increased maintenance and fuel costs. In fact, the actual cost of controls on current model cars averages only $460 per car, even if you include the full price of equipment, such as fuel injection and the computer control unit that performs important functions other than emission control. As a result of the use of this equipment, emissions have been drastically reduced while fuel economy has been significantly improved and maintenance costs reduced. Hence, while Brookings estimates total annual costs of $17 billion, our actual cost data indicate costs of less than $5 billion per year. The Brookings study calculates the benefits of the auto emissions program at $5.2 billion to $8.3 billion per year. These benefits exceed the actual costs of the program, even though no value has been given to improved health. Properly valuing human health benefits would clearly provide even greater net benefits.

The Brookings study clearly has understated benefits and exaggerated costs even by the most conservative estimates. The field of environmental regulation presents many complex and difficult issues. It is critical that all parties address these issues with the best available analytical tools. In those cases where we face uncertainties, errors should be made on the side of protecting public health.

—*Lee M. Thomas*

The writer is administrator of the Environmental Protection Agency.

Mr. Madigan. In one of your testimonies it was mentioned that EPA projects that there will be a 20-percent reduction in car and truck NO_x emissions between 1982 and the year 2000 with the EPA regulations that are already on the books, that my colleague from New York refers to.

Do you gentlemen concur with that?

Mr. Buist. Yes; we would. I believe what EPA is speaking to is that as newer vehicles replace older vehicles still maintaining as an example the 1 gram passenger car NO_x standard, improvements will automatically take place without a lowering of the standards.

Mr. Madigan. So the things that the gentleman from New York wishes to accomplish that Mr. Thomas from the EPA defends are going to be accomplished if we don't report this bill. Is that correct?

Mr. Buist. That is correct. There will be a continual improvement in passenger car as an example, NO_x in the car park, as newer vehicles replace older vehicles. That is right.

Mr. Madigan. I have no further questions, Mr. Chairman.

Mr. Waxman. If the gentleman will yield to me, I would point out and see if any of the panel members dispute this, that conclusion that you just agreed to was not the conclusion of the Envoy's report which has been endorsed by the President of the United States. Isn't that a correct statement?

Mr. Madigan. And which calls, if I may reclaim my time, for more research but not for any legislation.

Mr. Waxman. No, not more research on technologies for controlling SO_2 but not for the conclusion of inadequacies of present reductions in NO_x being inadequate to deal with the acid rain problem and I suppose there is a difference of opinion. Mr. Luken.

Mr. Luken. Do any of you gentlemen have any problem adopting the recommendations of the Envoy's report, the Lewis-Davis agreement that was arrived at between the representatives of our countries in an effort to solve this problem? Do you have any problem with the recommendations for action?

Mr. Klimisch. The $5 billion bothers me. I believe that should go through the normal appropriation process. I don't know that that is appropriate.

Mr. Buist. Congressman, we would support the Envoy report where it indicates that it suggested a 5-year control technology demonstration program that would select those control projects that have the greatest potential for reducing SO_2 and NO_x. That, in our mind, makes sense.

Mr. Luken. The Envoy's report did not recommend any change in NO_x standards, did it?

Mr. Buist. No; it did not.

Mr. Luken. It didn't even recommend any changes in Canada. What are the Canadian standards with reference to NO_x in comparison to the current U.S. standards?

Mr. Buist. Canada is somewhat more lenient in their standards. Let me give you just a flavor for how they compare to the United States. With respect to hydrocarbons, we are at 0.41; Canada is at 2 or about 5 times our level. With respect to CO, we are at 3.4; Canada is at 25 or about 7½ times. With NO_x, we are at 1 gram and Canada is at 3.1 or about 3 times our level.

Mr. Luken. I might advise the members of the panel and members of the subcommittee that when I pointed this out as one of the items where Canada was lagging behind to the Ambassador, who has been recently named as involved in lobbying on this issue with Mr. Deaver and others, his response, which is now in the Congressional Record at his insistence, was that Canada just does not produce as many cars as the United States and that was the reason he felt that the Canadian standards should be more lax and more liberal.

Mr. Madigan. Would the gentleman yield?

Mr. Luken. I would be glad to yield.

Mr. Madigan. As a matter of fact, we had them as a panel before this subcommittee and I was the one that asked the question, and they said that they needed more lead time to develop the technology and then I found that my car which met the United States standards was built in Canada. I thank the gentleman for yielding.

Mr. Luken. Does Canada have any plans to make their standards more strict with reference to automobiles and I am not talking about the loose kind of promises that they make every year, any specific plans?

Mr. Nield. I could submit for the record, if you like, a rulemaking that was just released by the Canadian Government about 2 or 3 weeks ago and it does make more stringent their standards up to the level of the present United States standards, 0.41, 3.4, 1, and 0.20.

Mr. Luken. But not to the level of that set forth in this proposed H.R. 4567, right?

Mr. Nield. This is a final rule of Canada and it would increase their stringency to the level of the current United States requirement and it would go into effect in September 1987.

Mr. Luken. So in September 1987, according to that rulemaking if it is carried out, in September 1987, they will catch up with the current standards but that will not be as strict as that which is called for in H.R. 4567.

Mr. Nield. That is correct.

Mr. Luken. It seems a little inequitable since Canada is lobbying for this legislation.

I ask unanimous consent that the document Mr. Nield has be introduced into the record of the proceedings of this subcommittee.

Mr. Waxman. What was that document again?

Mr. Nield. It is a publication in the Canada Gazette, Part Two, which is a final rule and it does change the requirement in Canada to be the same as the present United States emission requirements.

Mr. Waxman. Without objection, it will be entered into the record.

[Information to be furnished follows:]

AUTOMOBILE IMPORTERS OF CANADA.
A GROUP WITHIN CANADIAN IMPORTERS ASSOCIATION INC.
ASSOCIATION DES IMPORTATEURS CANADIENS INC.
WORLD TRADE CENTRE, 60 HARBOUR ST., TORONTO M5J 1B7, CANADA • TELEPHONE: (416) 862-0002
CABLE ADDRESS: "IMPORTANT", TORONTO • TELEX: 065-24115

C-86-16;
2/25/86

**SUBJECT: Motor Vehicle Safety Act;
Emissions Regulations Amended**

Enclosed is a copy of the CANADA GAZETTE publication (Part II, April 16, 1986; Vol. 120, Page 1626) which further regulates vehicle exhaust emissions by amending Sections 1100, 1101, 1102, 1103, 1105, and 1106 of the Motor Vehicle Safety Regulations.

George C. Nield
Engineering Advisor

ST:set
Enclosure

Registration
SOR/86-387 26 March, 1986

MOTOR VEHICLE SAFETY ACT

Motor Vehicle Safety Regulations, amendment

P.C. 1986-763 26 March, 1986

Whereas a copy of a proposed amendment to the Motor Vehicle Safety Regulations, substantially in the form set out in the schedule hereto, was published in the *Canada Gazette* Part I on August 3, 1985, and a reasonable opportunity was thereby afforded to manufacturers, distributors, importers and other interested persons to make representations to the Minister of Transport with respect thereto.

Therefore, Her Excellency the Governor General in Council, on the recommendation of the Minister of Transport, pursuant to sections 4* and 7 of the Motor Vehicle Safety Act**, is pleased hereby to amend the Motor Vehicle Safety Regulations, C.R.C., c. 1038, in accordance with the schedule hereto, marked Schedule No. 211, effective September 1, 1987.

SCHEDULE NO. 211

1. Section 1100[1] of Schedule V to the *Motor Vehicle Safety Regulations* is revoked and the following substituted therefor:

"1100. In this schedule,

"crankcase emission" means any air pollutant that is emitted into the atmosphere from any portion of the engine crankcase ventilation or lubrication systems; (*gaz de carter*)

"exhaust emission" means an air pollutant emitted into the atmosphere from any opening downstream from the exhaust port of a vehicle engine; (*gaz d'échappement*)

"fuel evaporative emission" means vaporized fuel emitted into the atmosphere from the fuel system of a motor vehicle; (*gaz d'évaporation de carburant*)

"gross vehicle weight" means the manufacturer's gross weight rating for a vehicle; (*poids brut*)

"heavy-duty vehicle" means, for the purpose of sections 1101 to 1105, and notwithstanding the definition "heavy-duty vehicle" in section 2, any motor vehicle rated at more than 3855.6 kg GVWR or that has a vehicle curb weight of more than 2721.6 kg or a basic vehicle frontal area in excess of 4.2 m²; (*véhicule lourd*)

"light-duty truck" means, for the purposes of sections 1101 to 1105, any motor vehicle rated at 3855.6 kg GVWR or

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* S.C. 1984, c. 40, s. 43
** R.S.C. 1970, c. 26 (1st Suppl.)
[1] SOR/79-115, 1979 *Canada Gazette* Part II, p. 493

Enregistrement
DORS/86-387 26 mars 1986

LOI SUR LA SÉCURITÉ DES VÉHICULES AUTOMOBILES

Règlement sur la sécurité des véhicules automobiles—Modification

C.P. 1986-763 26 mars 1986

Vu que le projet de modification du Règlement sur la sécurité des véhicules automobiles, conforme en substance à l'annexe ci-après, a été publié dans la *Gazette du Canada* Partie I, le 3 août 1985 et que les fabricants, les distributeurs, les importateurs et les autres personnes intéressées ont ainsi eu la possibilité de présenter au ministre des Transports leurs observations à ce sujet;

À ces causes, sur avis conforme du ministre des Transports et en vertu des articles 4* et 7 de la Loi sur la sécurité des véhicules automobiles**, il plaît à Son Excellence le Gouverneur général en conseil de modifier, conformément à l'annexe n° 211 ci-après et à compter du 1er septembre 1987, le Règlement sur la sécurité des véhicules automobiles, C.R.C., ch 1038.

ANNEXE N° 211

1. L'article 1100[1] de l'annexe V du *Règlement sur la sécurité des véhicules automobiles* est abrogé et remplacé par ce qui suit:

«1100. Les définitions qui suivent s'appliquent à la présente annexe.

«camionnette» Pour l'application des articles 1101 à 1105, tout véhicule dont le PNBV est d'au plus 3 855,6 kg, le poids à vide d'au plus 2 721,6 kg et la surface frontale de base d'au plus 4,2 m² et qui:

a) est conçu principalement pour transporter des biens ou a été modifié à partir de ce type de véhicule;

b) est conçu principalement pour transporter des personnes et qui compte plus de 12 places assises désignées.

c) présente des particularités qui lui permettent de rouler hors des voies publiques.

(*light-duty truck*)

«gaz de carter» Polluant de l'air émis dans l'atmosphère par le système de ventilation ou de lubrification du carter du moteur du véhicule. (*crankcase emission*)

«gaz d'échappement» Polluant de l'air émis dans l'atmosphère par toute ouverture, dans le système d'échappement, qui est en aval de l'orifice d'échappement du moteur d'un véhicule. (*exhaust emission*) less that has a vehicle curb weight of 2721.6 kg or less and a basic vehicle frontal area of 4.2 m² or less and that is

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* S.C. 1984, ch. 40, art. 43
** S.R.C. 1970, ch. 26 (1er suppl.)
[1] DORS/79-115, *Gazette du Canada* Partie II, 1979, p. 493

(*a*) designed primarily for purposes of transportation of property or that is a derivative of a vehicle that is so designed,

(*b*) designed primarily for transportation of persons and having designated seating capacity of more than 12 persons, or

(*c*) available with special features that enable it to be operated and used off-street or off-highway;

(*camionnette*)

"light-duty vehicle" means, for the purposes of sections 1101 to 1105, and notwithstanding the definition "light duty vehicle" in section 2, any motor vehicle designed primarily for the transportation of persons and having a designated seating capacity of not more than 12 persons; (*véhicule léger*)

"loaded vehicle weight" means the vehicle curb weight plus 136.1 kg; (*poids avec charge*)

"opacity", in relation to any plume of smoke, means the fraction of a beam of light, expressed in percent, that fails to penetrate the plume of smoke; (*opacité*)

"oxides of nitrogen" means the sum of the nitric oxide and nitrogen dioxide that would be contained in a gas if the nitric oxide were in the form of nitrogen dioxide; (*oxides d'azote*)

"system or device" means any modification of a vehicle or vehicle engine that prevents or lessens the emission of any air pollutant or noise into the atmosphere. (*système ou dispositif*)"

2. All that portion of subsection 1101(4) of Schedule V to the said Regulations preceding paragraph (*a*) thereof is revoked and the following substituted therefor:

"(4) Every light-duty vehicle and light-duty truck shall have permanently attached thereto, in a readily visible position in the engine compartment to equipment that is not easily detached from the vehicle and in such a manner that it cannot be removed without being destroyed or defaced, a plastic or metal label stating"

3. Section 1102 of Schedule V to the said Regulations is revoked and the following substituted therefor:

"1102. The crankcase of the vehicle engine shall be constructed in such a manner and be capable of being maintained in such condition that crankcase emissions are not discharged into the atmosphere."

4. Section 1103[3] of Schedule V to the said Regulations is revoked and the following substituted therefor:

"1103. (1) The hydrocarbon, carbon monoxide and oxides of nitrogen content of the exhaust emission from a vehicle powered by a gasoline-fueled or diesel-fueled engine and the particulate content of the exhaust emission from a vehicle powered by a diesel-fueled engine, when the vehicle is subjected to the "Motor Vehicle Safety Test Methods, Chapter IV, Section 1101—Vehicle Emissions," dated October 1,

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[3] SOR/80-383, 1980 *Canada Gazette Part II*, p. 1965

«gaz d'évaporation de carburant» Vaporisation de carburant émise dans l'atmosphère par le système d'alimentation en carburant d'un véhicule. (*fuel evaporative emission*)

«opacité» La fraction d'un faisceau lumineux, exprimée en pourcentage, qui ne réussit pas à traverser un panache de fumée. (*opacity*)

«oxydes d'azote» Le total d'oxyde nitrique et de bioxyde d'azote que contiendrait un gaz si l'oxyde nitrique était présent sous la forme de bioxyde d'azote. (*oxides of nitrogen*)

«poids avec charge» Dans le cas d'un véhicule, le poids à vide plus 136,1 kg. (*loaded vehicle weight*)

«poids brut» Dans le cas d'un véhicule, le poids brut nominal établi par le fabricant. (*gross vehicle weight*)

«système ou dispositif» Mécanisme installé dans un véhicule ou dans son moteur pour empêcher ou réduire l'émission de polluants de l'air ou de bruits dans l'atmosphère. (*system or device*)

«véhicule léger» Pour l'application des articles 1101 à 1105 et nonobstant la définition de «véhicule léger» à l'article 2, tout véhicule conçu principalement pour le transport de passagers et comptant au plus 12 places assises désignées. (*light-duty vehicle*)

«véhicule lourd» Pour l'application des articles 1101 à 1105 et nonobstant la définition de «véhicule lourd» à l'article 2, tout véhicule dont le PNBV est supérieur à 3 855,6 kg, dont le poids à vide est supérieur à 2 721,6 kg ou dont la surface frontale de base est supérieure à 4,2 m². (*heavy-duty vehicle*)»

2. Le passage du paragraphe 1101(4) de l'annexe V du même règlement qui précède l'alinéa *a*) est abrogé et remplacé par ce qui suit:

«(4) Les véhicules légers et les camionnettes doivent porter une étiquette de plastique ou de métal, fixée en permanence, bien en vue dans le compartiment du moteur, à une pièce qui n'est pas facilement détachable du véhicule, et de telle façon qu'il ne soit pas possible de l'enlever sans la détruire ou l'endommager; l'étiquette doit porter:»

3. L'article 1102 de l'annexe V du même règlement est abrogé et remplacé par ce qui suit:

«1102. Le carter du moteur d'un véhicule doit être construit de façon telle et pouvoir être maintenu dans un état tel que les gaz de carter ne soient pas rejetés dans l'atmosphère.»

4. L'article 1103[3] de l'annexe V du même règlement est abrogé et remplacé par ce qui suit:

«1103. (1) La teneur en hydrocarbures, en oxyde de carbone et en oxydes d'azote des gaz d'échappement d'un véhicule à essence ou à moteur diesel et la teneur en particules des gaz d'échappement d'un véhicule à moteur diesel, lorsque le véhicule est mis à l'essai selon les «Méthodes d'essai de sécurité des véhicules automobiles, chapitre IV, article 1101—Émissions des véhicules» en date du 1ᵉʳ octobre 1985, pour les véhicules légers et les camionnettes, et en date du

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[3] DORS/80-383, *Gazette du Canada Partie II*, 1980, p. 1965

1985 for light-duty vehicles and light-duty trucks and September 1, 1974, as amended by Revision No. 1 thereto dated January 8, 1979, for heavy-duty vehicles, shall not exceed

(*a*) in the case of a light-duty vehicle,

(i) 0.25 (0.41) g of hydrocarbons,

(ii) 2.1 (3.4) g of carbon monoxides,

(iii) 0.62 (1.0) g of oxides of nitrogen, and

(iv) 0.12 (0.20) g of diesel particulate,

per vehicle km (mile);

(*b*) in the case of a light-duty truck,

(i) 0.50 (0.80) g of hydrocarbons,

(ii) 6.2 (10) g of carbon monoxides,

(iii) 0.75 (1.2) g of oxides of nitrogen for a light-duty truck having a loaded vehicle weight of 1701.0 kg or less or 1.1 (1.7) g of oxides of nitrogen for a light-duty truck having a loaded vehicle weight of over 1701.0 kg, and

(iv) 0.16 (0.26) g of diesel particulate,

per vehicle km (mile); and

(*c*) in the case of a heavy-duty vehicle,

(i) a total of 6.0 (16) g of hydrocarbons and oxides of nitrogen,

(ii) 15 (40) g of carbon monoxide,

per megajoule (brake horsepower-hour).

(2) Where a light-duty vehicle or light-duty truck is modified by a system or device, the system or device shall be designed to assist or enable the vehicle to meet the requirements of subsection (1).

(3) The maximum carbon monoxide content at curb idle of the exhaust gases from a gasoline-fueled light-duty truck engine, when subjected to the "Motor Vehicle Safety Test Methods, Chapter IV, Section 1101—Vehicle Emission" dated October 1, 1985 shall not exceed 0.50 per cent of exhaust gas flow."

5. Section 1105[2] of Schedule V to the said Regulations is revoked and the following substituted therefor:

"1105. The evaporative emissions from any light-duty vehicle or light-duty truck that is gasoline-powered shall not exceed 2.0 g of hydrocarbons when subjected to the "Motor Vehicle Safety Test Methods, Chapter IV, Section 1101—Vehicle Emissions" dated October 1, 1985."

6. Section 1106[1] of Schedule V to the said Regulations is amended by adding thereto the following subsection:

"(3) For the purposes of this section, the definition "light-duty vehicle" in section 2 shall be read as though for the words "an off-road utility vehicle" therein there were substituted the words "any vehicle having a gross vehicle weight

1er septembre 1974, modifiées par la révision nº 1 du 8 janvier 1979, pour les véhicules lourds, ne doivent pas dépasser:

a) dans le cas d'un véhicule léger, par kilomètre (mille) de distance parcourue:

(i) 0,25 (0,41) g d'hydrocarbures,

(ii) 2,1 (3,4) g d'oxyde de carbone,

(iii) 0,62 (1,0) g d'oxydes d'azote,

(iv) s'il s'agit d'un véhicule à moteur diesel, 0,12 (0,20) g de particules;

b) dans le cas d'une camionnette, par kilomètre (mille) de distance parcourue:

(i) 0,50 (0,80) g d'hydrocarbures,

(ii) 6,2 (10) g d'oxyde de carbone,

(iii) 0,75 (1,2) g d'oxydes d'azote, s'il s'agit d'une camionnette dont le poids avec charge est d'au plus 1,701,0 kg, ou 1,1 (1,7) g d'oxydes d'azote, s'il s'agit d'une camionnette dont le poids avec charge est supérieur à 1,701,0 kg,

(iv) s'il s'agit d'un véhicule à moteur diesel, 0,16 (0,26) g de particules;

c) dans le cas d'un véhicule lourd, par mégajoule (cheval-vapeur-heure):

(i) 6,0 (16) g d'hydrocarbures et d'oxydes d'azote, au total,

(ii) 15 (40) g d'oxyde de carbone.

(2) Le système ou le dispositif installé dans un véhicule léger ou une camionnette doit être conçu de façon à assurer, soit seul ou en combinaison avec d'autres éléments, le respect des exigences applicables énoncées au paragraphe (1)

(3) Au ralenti, la teneur maximale en oxyde de carbone des gaz d'échappement d'une camionnette ayant un moteur à essence, mise à l'essai selon les «Méthodes d'essai de sécurité des véhicules automobiles, chapitre IV, article 1101—Émissions des véhicules» en date du 1er octobre 1985, ne doit pas dépasser 0,50 pour cent.»

5. L'article 1105[2] de l'annexe V du même règlement est abrogé et remplacé par ce qui suit:

«1105. La teneur en hydrocarbures des gaz d'évaporation d'un véhicule léger ou d'une camionnette qui ont un moteur à essence ne doit pas dépasser 2,0 g lorsque le véhicule est mis à l'essai selon les «Méthodes d'essai de sécurité des véhicules automobiles, chapitre IV, article 1101—Émissions des véhicules» en date du 1er octobre 1985.»

6. L'article 1106[1] de l'annexe V du même règlement est modifié par adjonction de ce qui suit:

«(3) Pour l'application du présent article, la définition de «véhicule léger» figurant à l'article 2 doit être interprétée comme si les mots «véhicule utilitaire pour service hors route» étaient remplacés par «un véhicule d'un poids brut

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[1] SOR/79-115, 1979 *Canada Gazette* Part II, p. 493

[2] SOR/80-385, 1980 *Canada Gazette* Part II, p. 1965

[1] DORS/79-115, *Gazette du Canada* Partie II, 1979, p. 493

[2] DORS/80-385, *Gazette du Canada* Partie II, 1980, p. 1965

of 2721.6 kg or less that is designed for carrying persons, property or a work-performing structure and that incorporates special features for off-road operations"."

EXPLANATORY NOTE

(This note is not part of the Regulations.)

This amendment

(*a*) imposes more stringent standards for exhaust and evaporative emissions from light-duty vehicles and light-duty trucks;

(*b*) introduces new exhaust and evaporative emissions test procedures for light-duty vehicles and light-duty trucks;

(*c*) adds the definitions "light-duty vehicle", "light-duty truck", "heavy-duty vehicle" and "loaded vehicle weight" to Schedule V; and

(*d*) deletes the definition "off-road utility vehicle" in Schedule V, but retains the substance of that definition in section 1106 in relation to noise emissions.

d'au plus 2 721,6 kg, conçu pour transporter des personnes, des biens ou de l'équipement et présentant des particularités qui lui permettent de rouler en dehors des routes».»

NOTE EXPLICATIVE

(La présente note ne fait pas partie du règlement.)

Les modifications visent à:

a) rendre plus strictes les normes applicables aux gaz d'échappement et d'évaporation des véhicules légers et des camionnettes;

b) introduire de nouvelles méthodes d'essai visant les gaz d'échappement et d'évaporation des véhicules légers et des camionnettes;

c) définir à l'annexe V les termes «véhicule léger», «camionnette», «véhicule lourd» et «poids avec charge»;

d) supprimer la définition de «véhicule utilitaire pour service hors route» à l'annexe V et à restreindre son application à l'article 1106.

Mr. **Luken**. For further explanation of the document, is the Canada Gazette some kind of an official or semiofficial entity sort of like our Federal Register?

Mr. **Nield**. Exactly.

Mr. **Luken**. All right. Without objection, the chairman indicated that that is entered.

Now we have been discussing improvements in these hearings and yesterday was referred to by some of the proponents of this legislation who were testifying that those who have made improvements, such as possibly the State of New York has, possibly, we are going to find that out, should be rewarded as opposed to maybe Ohio.

Whether or not they have, we will find that out, but as you pointed out the vehicle manufacturers have already reduced tailpipe emissions in hydrocarbons by 96 percent and 75 percent for NO_x. Isn't that approximately correct?

I see nodding. Would somebody say yes?

Mr. **Klimisch**. Yes, sir.

Mr. **Buist**. Yes, sir.

Mr. **Luken**. The National Commission on Air Quality found that by 1987 the contribution of mobile sources to overall hydrocarbon emissions in major urban areas will be no more than 20 to 30 percent depending upon the area. That is a correct statement.

I would just like to conclude by observing, and I am sorry that the gentleman from New York isn't here, that we oftentimes have excessive zeal for regulation and fortunately we back off.

For example, recently in Ohio the EPA claiming to be enforcing the Clean Air Act put in a rule or put in a requirement for tailpipe emissions for Cleveland and Cincinnati, a rather ridiculous kind of a thing because the air wasn't any worse in Cleveland and Cincinnati than in other parts but some quirk in the law, but we talked to them and kept talking to them and finally they reduced the sentence that Ohio has to serve. It is not a tailpipe emissions testing but a tampering process which was put into effect and the reason is that there has been this improvement in the hydrocarbon emissions and in the air quality generally.

I thank the chairman for his tolerance.

Mr. **Waxman**. Thank you, Mr. Luken.

Mr. Coats.

Mr. **Coats**. Thank you, Mr. Chairman, and again I want to thank you for allowing me to participate on this subcommittee even though I am not a member of the subcommittee but of the full committee.

I would like to ask some bottom line questions—of all the various auto company representatives. Maybe you don't have all the answers, but I think it is important for the record at some point before we proceed with this legislation to know these numbers and so if you don't have them available, perhaps we can ask unanimous consent to have them supplied for the record.

Basically my questions or the points that I would like to establish are what is the bottom line cost per unit that each of your companies is going to be facing if this bill is enacted into law, what effect does it have on the fuel economy, and third, what are your plant utility costs going to be to comply with this law?

If any of the representatives have this information at hand, I would like to get it on record now. If not, we will let you submit it. [See p. 161.]

Mr. **Klimisch**. If I may, some of the largest costs are going to be in the truck area and certain categories of trucks where we estimate $250 per truck cost for provisions in this law and 6 to 7 percent loss in fuel economy for those trucks.

It will eliminate certain weight categories of trucks. Our utility costs overall, we estimate are at least $75 million per year and maybe more.

Mr. **Coats**. Anybody else?

Mr. **Robertson**. We will be glad to supply the best numbers that we have. I would just like to elaborate a little further that there is a wide spectrum of impact as Dr. Klimisch has indicated from the passenger car NO_x standard which will be a relatively modest amount due to the increased catalyst and hardware requirements to improve in-use compliance at the more stringent standards ranging all the way up to the heavy-duty truck where we have to speculate what it will take to meet an extremely stringent standard and then applied to all vehicles is the potential of onboard refueling loss which is another separable chunk of hardware and we will be glad to estimate that.

Mr. **Coats**. Mr. Buist.

Mr. **Buist**. We will have to supply those numbers for the record. I did indicate that our utility costs were in the area of a $24 million annual increase but I will go back and develop. We just haven't had time to develop the fuel economy impact on our vehicles as well as the cost and we will do that.

Mr. **Coats**. Does anybody else wish to comment? Mr. Nield.

Mr. **Nield**. It might be interesting, our members have quite a range of vehicles from high performance, very expensive cars to the lower priced models that are more in demand by many consumers. The interesting thing, I think, is that the high performance expensive cars come much closer to meeting the requirements now because of their fuel injection and extra cost items for performance reasons that lead the way toward meeting tighter emission standards.

However, the more economical vehicles and the ones that are really in demand by many in the population, the costs would be much, much greater to bring the vehicle into compliance.

Mr. **Coats**. That would have an inversely proportional effect on fuel economy, I would think.

Mr. **Nield**. That is true.

Mr. **Coats**. I think one of the things that the committee needs to look at is the cost benefit ratio of what we are about to do and it seems to me we haven't yet fully assessed just what the cost impact would be if this bill were enacted into law. I think, Mr. Chairman, it is very important that we have those figures before us.

Mr. **Waxman**. Would the gentleman yield to me for a quick question? Are you basing your conclusions about the cost of this bill in terms of electricity costs to you on the Edison Electric Institute study?

Mr. **Buist**. I believe that is correct, Mr. Chairman, but I will have to double check that.

Mr. **Waxman**. Mr. Klimisch.

Mr. **Klimisch**. Yes.

Mr. **Waxman**. You are. Thank you.

Mr. **Coats**. The second question I have is that the statement has been made by proponents of the bill that the truck NO_x provisions have been basically characterized here as simply a codification of EPA regulations. Is that the case and if that is the case, I don't see what the problem is.

Mr. **Klimisch**. No. In fact, they were characterized as that but that is not true. They are much more stringent than that.

Mr. **Coats**. Could you detail that a little bit for us?

Mr. **Klimisch**. For gasoline powered trucks, it goes from 6 grams per brake horsepower down to 1.7. So it is much more stringent. I think it is 1.7 down to 1.2 for the other trucks, so it is much more stringent than the current EPA rule.

Mr. **Coats**. So what the bill does, does not simply codify currently existing EPA regulations?

Mr. **Klimisch**. No, sir.

Mr. **Coats**. It would impose a much stricter standard on you than current EPA regulations?

Mr. **Klimisch**. Yes, it does.

Mr. **Coats**. And it goes into effect for 1989 automobiles and trucks, is that correct?

Mr. **Klimisch**. Some of them are 1988, which is virtually impossible.

Mr. **Coats**. Which come out in the fall of 1987.

Mr. **Klimisch**. Yes.

Mr. **Coats**. That is a problem for you, not just a minor change.

Mr. **Klimisch**. No. It is almost impossible. Those designs are finalized.

Mr. **Coats**. In fact, you are in the certification process now, isn't that right?

Mr. **Klimisch**. Yes, that is true.

Mr. **Coats**. Thank you, Mr. Chairman.

Mr. **Waxman**. Thank you, Mr. Coats.

Mr. Walgren.

Mr. **Walgren**. I have no questions. Thank you, Mr. Chairman.

Mr. **Waxman**. Mr. Richardson.

Mr. **Richardson**. Thank you, Mr. Chairman. I apologize for coming in late. I don't know if this question was asked but industry representatives that have come to see me to discuss this bill, besides some of them stating their opposition, they mention that they object also to the fast track nature of this bill, that it is proceeding on a very rapid pace and the implications and the impact of the bill on their respective industry cannot be weighed.

Just leafing through some of your statements and I didn't hear you make your statements, I wondered if there was anything specific related to your industry that besides the substantive opposition you might have to a specific motor vehicle emission standard that would fall in the category of needing further scientific study and what is it specifically that you would on these grounds believe that we need more time to assess it and I will withdraw my question if this has been answered already.

Mr. **Klimisch**. I think that perhaps one of the most important questions, scientific questions, has to do with the role of nitrogen oxides in the environment both in terms of the things that it does to acid rain in terms of the lack of benefits that come out of that plus the effects it has in other aspects of air pollution, particularly on ozone.

The regulators have not taken a position on that and they have avoided taking positions on that, particularly EPA. I would hope some day that they will address that tradeoff problem.

Mr. **Buist**. Congressman, and I indicated this before, it is one of frustration. When the bill proposes the standard that we were just discussing a minute ago, a 1.7, versus EPA's existing standard of 6 with EPA going to 5 in 1991, a 1.7 standard in 1988 is just totally an undoable situation. The technology does not exist to get there.

On top of that, there is additional frustration because of what EPA tells us about the NO_2 levels across the United States and the fact that the United States is basically in compliance with the exception of California. So we struggle with the need.

Mr. **Richardson**. Mr. Chairman, I have no further questions. I am a little confused on this issue because it seems that the President and the National Academy of Science, I believe, did endorse the nitrogen oxide standards that we just discussed, in other words, the level.

I am trying scientifically to get an assessment from these people. Maybe my last question would be, is there any recorded fact or figure for what the industry has spent on compliance with the Clean Air Act? Is there any ballpark estimate of what you have spent to comply with that act?

Mr. **Robertson**. Are you speaking of emissions control?

Mr. **Richardson**. Yes.

Mr. **Robertson**. I think we can go back and supply that for the record. I don't have it here. [See p. 4.]

Mr. **Waxman**. We will hold the record open to receive that information. Mr. Bliley.

Mr. **Bliley**. No questions, Mr. Chairman.

Mr. **Waxman**. Ms. Collins.

Ms. **Collins**. I don't have any questions of this panel, Mr. Chairman, however I do have a concern. In my district in Chicago I have the meeting together of some two major arteries leading into our city. Early in the mornings when people are coming in from all over the suburban areas we find the level of automobile emissions to be extremely high, perhaps one of the highest levels in the Midwest if not in the country.

It has been a great concern of my constituents for many years now that something be done about auto emissions, because this very high level seems to be endangering the general overall health of those who not only work in the area, but those that reside in that area.

Although I arrived here late, having come from another meeting, I was very interested in obtaining the testimony of these witnesses, will look it over and perhaps will have some questions for them in writing later. I yield back the balance of my time.

Mr. **Waxman**. Thank you very much, Ms. Collins.

Mr. Dingell.

Mr. DINGELL. Thank you, Mr. Chairman. Gentlemen, this question is to anybody, What percentage of the fleet can now meet the 1981 standards, the automobile fleet, approximately?

Mr. KLIMISCH. About 40 percent, maybe under that.

Mr. DINGELL. How soon will all of the fleet meet those standards?

Mr. KLIMISCH. The fleet won't turn over for 15 years.

Mr. DINGELL. So we can anticipate that within about 3 or 4 years, the problems just referred to would have significantly abated under existing law, is that correct, because of the retirement of the old, dirty, inefficient engines?

Mr. KLIMISCH. Yes, sir. In fact, most of the problems have retired. All of those monitoring sites have shown rather dramatic reductions, particularly of carbon monoxide.

Mr. DINGELL. Now gentlemen, this question is particularly to Mr. Buist and Mr. Klimisch, you have testified that the motor vehicle standards in H.R. 4567 are not merely a codification of promulgated regulations and that the bill in some cases changes these regulations. Is that correct?

Mr. KLIMISCH. Yes, sir.

Mr. BUIST. Yes.

Mr. DINGELL. Now I understand that the relevant regulations cover more than merely the standards. They include a number of narrative provisions in the regulations that relate to the implementation and enforcement of regulations. The bill does not mention them. Do you agree then that there is nothing in the bill that preserves those regulations?

Mr. BUIST. Yes, we would, Congressman. The bill only addresses the standards themselves. There are other aspects of overall compliance as you know that are of equal importance and whenever you address standards, you can't address standards without addressing test procedures as an example.

Let me give you a couple of quick examples of what I am speaking to. A recent EPA rulemaking involving light-duty trucks for useful life, they established a useful life which we thought was considerably in excess of appropriate levels.

Heavy-duty engine certification, the driving cycle used on the dynamometer was significantly modified which impacted the standards. Those are the kinds of things that have to be addressed along with the standards.

Mr. DINGELL. That would then leave us with the fair probability that EPA would under this legislation have to commence an entirely new rulemaking procedure to address the ambiguities in the legislation. Is that not correct?

Mr. KLIMISCH. Yes, most likely.

Mr. BUIST. Yes, I assume that would be.

Mr. DINGELL. So EPA would then, if this bill passes in its current form, because of the comments you have just made and because of the differences between the regulations and the bill, probably would have to commence an entirely new rulemaking process to deal with those questions. Is that not so?

Mr. KLIMISCH. Yes.

Mr. DINGELL. Now if they did so, what would be the consequences in terms of lost time and ambiguity with regard to automobiles and air pollution standards and with regard to automobiles and trucks and light trucks?

Mr. KLIMISCH. It is already too late and any further delay is going to make it further impossible.

Mr. DINGELL. Now why do you say that? Essentially you are saying that the new standards could not then be met? Is that correct?

Mr. KLIMISCH. Yes.

Mr. DINGELL. Within the timeframe that exists?

Mr. KLIMISCH. Yes, sir, particularly for the 1988 model year, that is out of the question.

Mr. DINGELL. What is the state now of the 1988 model year?

Mr. KLIMISCH. They are undergoing certification now.

Mr. DINGELL. They are undergoing certification.

Mr. KLIMISCH. It would be absolute panic to change that now.

Mr. DINGELL. What about the following model year, the 1989 model year?

Mr. KLIMISCH. That is pretty solid at this point. Changing that would be very expensive in terms of money and resources.

Mr. DINGELL. So the 1988 model year is now undergoing the 50,000 certification test. That would have to be changed.

Mr. KLIMISCH. In the case of the trucks, they are 120,000 because of this life rule that EPA made.

Mr. DINGELL. How long would it take to rerun the certification tests that would be required by this change for a truck or for a motor vehicle?

Mr. KLIMISCH. Six months.

Mr. DINGELL. Gentlemen, I would appreciate your written response. I will submit a written question to each of you which I ask unanimous consent on this and on other matters be inserted in the record at the appropriate point.

Mr. WAXMAN. Without objection, we will receive written responses to questions by Mr. Dingell and other members of the committee and they will be put in the record at the appropriate point. [See p. 161.]

Mr. DINGELL. Gentlemen, I understand that several of these standards according to the bill are required for model year 1988 which begins in 1987 for some companies. I understand that one of the Senate bills on acid rain introduced last March would require even more stringent standards raising the possibility that in conference the standards could then be changed so as to constitute significantly more than mere codification.

What does that do to the industry if that situation occurs?

Mr. KLIMISCH. Some of the measures in that bill are absolutely impossible. It would basically eliminate heavy-duty trucks. It is a very frightening possibility.

Mr. WAXMAN. The gentleman's time has expired. Mr. Dingell, do you wish additional time?

Mr. DINGELL. I would like, Mr. Chairman, to ask unanimous consent to proceed for a brief additional period on this matter.

Mr. WAXMAN. Let's go for an additional 2 minutes.

Mr. DINGELL. Thank you, Mr. Chairman.

Mr. WAXMAN. Without objection.

Mr. DINGELL. What are the lead times imposed by Congress on EPA and is the bill, H.R. 4567, consistent with them? I understand it is 4 years for heavy-duty trucks. Is that correct?

Mr. BUIST. That is correct, Congressman.

Mr. DINGELL. What would this bill then do with that matter?

Mr. BUIST. It is inconsistent. As an example, for heavy-duty trucks, they are establishing the 1.7 NO_x standard for the model year 1988. First of all, right now technology does not exist to handle that level and we are out of lead time before we can even start.

Mr. DINGELL. Now Mr. Nield, could your member firms install an on-board system by the year 1989 especially since EPA has not set regulations on the testing requirements?

Mr. NIELD. It seems to be very, very unlikely that any of them could meet that kind of a schedule, sir.

Mr. DINGELL. Now gentlemen, what is the source of the content of catalysts for known technology and what are those metals and where do they come from?

Mr. KLIMISCH. The metal that is crucial in there is rhodium but that is accompanied by platinum and in some cases palladium and that mostly comes from South Africa. Some comes from Russia.

Mr. DINGELL. So passage of this change would require additional imports from South Africa?

Mr. KLIMISCH. Oh, yes, and it might require a lot of money being sent to one of those two countries.

Mr. DINGELL. I see. Now would you please give us a statement of the differences in standard for NO_x and HC in both the United States and Canada for 1987 and following years both with regard to automobiles and please submit this for the record and with regard to trucks.

Can you tell us when Canada will adopt United States standards for both trucks and automobiles?

Mr. BUIST. For automobiles, Congressman, that will be the 1988 model year.

Mr. DINGELL. The Canadians will adopt United States standards in 1988?

Mr. BUIST. That is what they have indicated in their Gazette which is equivalent to our Federal Register.

Mr. WAXMAN. Thank you, Mr. Dingell. The time has expired. Gentlemen, we appreciate your testimony and we will look forward to further responses to questions from members of the subcommittee in writing.

[Testimony resumes on p. 181.]

[The following letters were submitted for the record:]

Donald R. Buist
Director
Automotive Emissions and
Fuel Economy Office
Environmental and Safety
Engineering Staff

Ford Motor Company
The American Road
Dearborn, Michigan 48121

June 5, 1986

Ms. Karen Nelson
Staff Director
Subcommittee on Health and the Environment
U.S. House of Representatives
Room 2424, Rayburn House Office Building
Washington, D.C. 20515

Dear Ms. Nelson:

Attached to this letter are Ford Motor Company's responses to questions raised at the May 1, 1986 hearing on H.R. 4567, "Acid Deposition Control Act." The supplemental material for the record are referenced by page and line numbers which appear in the transcript of the hearing.

If there are any other issues or questions regarding Ford's position on this proposed legislation, please call on me.

Sincerely,

D.R. Buist

D. R. Buist

Attachment

REB.15

ACID DEPOSITION CONTROL ACT

Ford Motor Company's (Ford) supplemental information to Donald R. Buist's testimony of May 1, 1986 requested for the record by the Subcommittee on Health and the Environment.

I. Page 45, Line 907-909: Mr. Ritter. "Mr. Chairman, I ask unanimous consent that these gentlemen be allowed to submit for the record the cost impact of H.R. 4567."

Page 63, Line 1338-1343: Mr. Coats. "Basically my questions or the points that I would like to establish are what is the bottom line cost per unit that each of your companies is going to be facing if this bill is enacted into law, what effect does it have on the fuel economy, and thirdly, what are your plant utility costs going to be to comply with this law."

(1) Cost per unit. Ford estimates that the consumer price, on a retail price equivalent basis*, would be $27 and $85 per average Ford passenger car and light truck, respectively (at 1986 economics), to comply with the emission levels proposed by H.R. 4567. As Mr. Buist stated in his testimony, Ford does not believe that the 1.7 g/bhp-h NO_x level originally proposed by H.R. 4567 for heavy-duty gasoline engines is technologically feasible at any time in the foreseeable future. Consequently, Ford cannot develop a cost estimate.

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* The retail price equivalent (RPE) reflects estimated manufacturing costs and investment write-off to meet regulations, and represents an assessment of the incremental impact of adopting such requirements on Ford's vehicles. The RPE includes a normal manufacturer's profit and dealer markup.

(2) Fuel Economy Impact. Ford has updated its preliminary analysis, and estimates that the 0.7 gpm NO_x provision in H.R. 4567 could result in a passenger car corporate average fuel economy (CAFE) penalty of 0.4 mpg. The combined fuel economy effect of the light truck NO_x and HC provisions of H.R. 4567 is estimated to be as high as 1.0 mpg CAFE penalty.

(3) Plant Utility Costs. As Mr. Buist indicated in his testimony (page 64, line 1371), Ford's annual power costs (for purchased utilities) resulting from the provisions of H.R. 4567 could increase up to $24 million. Moreover, Ford has numerous coal-fired industrial boilerhouses, electric power plant, and coke-oven gas as primary sources targeted for control. The cost for low sulfur coal cannot be estimated at this time, but the desulfurization of coke oven gas alone would cost approximately $10 million (capital) and operating costs of $2 to 3 million per year.

II. Page 69, Line 1490-1493: Mr. Richardson. "...is there any recorded fact or figure for what the industry has spent on compliance with the Clean Air Act? Is there any ballpark estimate of what you have spent to comply with that Act?"

In a publication entitled "Expenditures for Abating Pollutant Emissions from Motor Vehicles, 1968-84" (which appeared in the July, 1985 issue of the Survey of Current Business), the U.S. Department of Commerce (DOC) estimated the initial pollution control hardware costs as well as the operation and maintenance costs for passenger cars and light- and heavy-duty trucks. On an industry-wide basis, the lifetime emission control hardware costs (1968 to 1984) were estimated to be $63 billion. The operational and maintenance costs would add an estimated $54 billion, for a total pollutant control cost of $117 billion for the period 1968 to 1984.

Ford extrapolated these data, and used calendar year 1985 sales information and an economic factor of 4.5% (to adjust cumulative data to 1985 dollars) to develop the estimates for 1985 and lifetime costs. The 1985 emission hardware costs on an industry-wide basis are estimated to be about $14 billion and the operational costs were calculated at $11 billion. Using the DOC estimates, the total pollutant control cost approaches $142 billion for the period 1968 to 1985.

It is also important to note that during this time period, the regulatory requirements to meet the ever changing and more stringent emission standards caused difficulties and constraints in complying with the vehicle fuel economy demands and CAFE requirements.

Ford Motor Company

June 5, 1986

REB.13

VOLKSWAGEN OF AMERICA, INC.
888 W. Big Beaver
P.O. Box 3951
Troy, Michigan 48007-3951
Tel (313) 362-6000
WU Telex — 230 828

June 6, 1986

U.S. House of Representatives
Committee on Energy and Commerce
Subcommittee on Health and the Environment
2415 Rayburn House Office Building
Washington, D.C. 20515

Subject: H.R. 4567, "The Acid Deposition Control Act of 1986"

On May 1, 1986, Volkswagen of America, Inc. (Volkswagen) presented testimony at a hearing before the Subcommittee on Health and the Environment considering H.R. 4567, amendments to the Clean Air Act. After the witnesses of Panel #1, representatives of the automobile industry, provided their prepared statements, a number of questions were asked of the participants. Some of these questions required additional research. Therefore, the Subcommittee Chairman allowed additional time for the submission of responses to these questions. While no questions were specifically addressed to Volkswagen, there were some questions posed to the panel in general. These questions dealt primarily with the cost impact of the provisions of H.R. 4567. For the sake of clarity, the questions are restated below preceeding Volkswagen's response.

1) What is the projected cost impact that would result in a change in utility rates due to H.R. 4567?

Volkswagen operates one U.S. vehicle production facility at Westmoreland, Pennsylvania and is supplied electricity by West Penn Power Company. Actual electrical utility usage between April 1985 and March 1986 was in excess of 101,000,000 kilowatt-hours (kwh) at a total cost of nearly $3.3 million dollars.

In a study compiled by the Edison Electric Institute, which assesses the cost impact of H.R. 4567, the annual compliance cost and average rate increase for West Penn Power Company is calculated to be $79 million and a nine percent increase respectively. Assuming this rate increase will be passed on directly to the consumer, the electric utility cost at the Westmoreland facility will increase by approximately $300,000 per year.

Audi Volkswagen

This increase may appear small, however it is very conservative and does not reflect the production cost increases that will be experienced when suppliers of other utilities, vehicle components and other sources for which Volkswagen is a customer, pass on their increase in utilities rates in the form of higher prices. As an example, although the cost of electricity per vehicle is about $35 for those vehicles produced at Westmoreland, the total energy cost per vehicle is about $83. An increase in electric utility rates will likely cause an increase in natural gas, water and sewage rates as well and proportionally increase the total energy cost per vehicle.

2) What is the projected cost of compliance with the mobile source provisions of H.R. 4567?

As stated in Volkswagen's testimony, although the proposed 0.7 g/mi NOx emission standard is required to be met by all passenger cars, the degree of difficulty in complying with this particular exhaust emission standard varies for two distinct types of vehicles produced by Volkswagen, gasoline-fueled and diesel-powered.

For gasoline-fueled light-duty vehicles, Volkswagen has certified to the 0.7 g/mi NOx emission standard in California; however there is always some concern over the ability to meet this emission level in-use when vehicles are subjected to adverse conditions, such as poor fuel quality, severe use or lack of maintenance, which are beyond the manufacturer's control. The cost to comply with 0.7 g/mi NOx for gasoline-fueled vehicles therefore, cannot be associated with any major changes in emission control hardware. Cost increases might be expected to manifest themselves in the form of increased in-use liability or perhaps warranty claims. At present, it is not possible to assign a dollar amount to this increased risk.

With respect to Volkswagen diesel-powered vehicles, compliance with the 0.7 g/mi NOx standard is not currently technologically feasible. As such, a cost for compliance cannot be assigned. If subject to the 0.7 g/mi NOx standard, Volkswagen would be forced to withdraw from the diesel-powered vehicle market. The costs incurred would be those associated with lost opportunity. As stated in Volkswagen's testimony, preservation of this technology is important because it provides a product to a specific segment of the market and its continued availability encourages further development and refinement. In the event of a future fuel shortage the value of this development and refinement will increase.

H.R. 4367 also proposes to require that EPA promulgate regulations intended to control the loss of fuel vapors during the refueling process. Two strategies are suggested; refueling vapor control at the service station or refueling vapor control on-board the vehicle. If a service station control strategy is implemented, the automobile manufacturer's cost would be negligible. In fact, most, if not all vehicles, are already compatible with this system since it has been operational in California for a number of years. The second strategy consists of on-board vehicle vapor recovery. Volkswagen has been investigating this type of control system and provided comments on it's necessity, development and cost in response to EPA action on this issue. In its comments Volkswagen stated the following:

> "Since system design critical parameters such as test procedure and fuel specifications have not been established, a firm cost for an on-board system cannot be determined. However, through Volkswagen's limited testing and examination of candidate systems Volkswagen has arrived at a projected on-board control system cost of $72. This figure is based on preliminary design and prototype components. Volkswagen's estimate may be somewhat low at this time since it does not account for test procedure effects or component modifications which will be necessary with an increase in the volatility of test fuel. The overall effect on vehicle design also cannot be determined at this time, however this consideration has been taken into account to the extent possible."

This concludes Volkswagen's response to those questions posed to the panel in general. Once again, Volkswagen appreciates the opportunity to participate in this legislative action.

Sincerely,
VOLKSWAGEN OF AMERICA, INC.

D.K. Haenchen
Executive Engineer
Vehicle Regulations

Environmental Activities Staff
General Motors Corporation
General Motors Technical Center
Warren, Michigan 48090

June 9, 1986

The Honorable Henry A. Waxman
Chairman, Health and The Environment
Subcommittee
U. S. House of Representatives
2418 Rayburn House Office Bldg.
Washington, D.C. 20510

Dear Mr. Chairman:

In response to several questions asked by Chairman John D. Dingell and Representative Don L. Ritter during the Acid Rain hearing (H.R. 4567), May 1, 1986, General Motors hereby submits for the record, the following attached responses.

Sincerely,

RL Klimisch

R. L. Klimisch

Submission for the Record
Requested at 5/1/86 Acid Rain Hearing

1. Rep. Ritter: "...I would ask unanimous consent that Dr. Klimisch have the opportunity to provide for the record his basis for concluding that the rhodium supply for the catalytic converters to do the job is not going to be available."

The only major rhodium sources are South Africa, which has 90 percent of the world's supply, and the Soviet Union.

Rhodium is basically a by-product of platinum mining. South African mines produce one troy ounce of rhodium for each twenty ounces of platinum mined, and producers are unwilling to mine solely for rhodium because it would create an excess supply of platinum.

The automobile market is using increasing amounts of rhodium to meet current regulations, and the auto sector is projected to use approximately 80 percent of the available rhodium supply by 1990.

GM projects world automotive demand in 1990 of at least 200,000* troy ounces of rhodium. Other industries' demands would bring this up to over 250,000 troy ounces.

The most realistic forecasts of 1990 availability project rhodium production of 195,000 troy ounces. This would yield a shortfall of over 50,000 troy ounces in 1990 alone. Again, this shortfall assumes the current regulatory environment. More stringent standards would exacerbate this shortfall.

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*Current year vehicle production times 1990 rhodium loading projections.

2. Rep. Ritter: "...I ask unanimous consent that these gentlemen be allowed to submit for the record the cost impact of H.R. 4567."

We estimate a $75 million annual increase to GM in electricity costs attributable to the stationary source provisions of the proposed legislation previously mentioned in the General Motors testimony before the Committee.

With respect to mobile source provisions, current regulations do not allow for a catalyst change, yet this provides the only means for compliance for most light-duty trucks. These vehicles would require a catalyst change at approximately 60,000 miles, or half the extended "useful life" at a cost of $350 million.

Depending on the engine family, a federal 0.7 gpm passenger car NOx standard could result in cost, driveability and fuel economy penalties. For example, increased rhodium use in the catalyst will generate higher costs (see previous question). Increased exhaust gas recirculation (EGR) and/or retarding spark timing in order to reduce NOx emissions would adversely affect driveability and fuel economy.

And, if the EPA Administrator were to select vehicle onboard technology as the approach to controlling refueling vapor control, we estimate an additional annual cost to GM customers of approximately $150 million, exclusive of sheet metal changes and their associated costs.

3. Rep. Dingell: "Now would you please give us a statement of the differences in standards for NOx and HC in both the U.S. and Canada for the 1987 and following years both with regard to automobiles and trucks and please submit this for the record."

The differences between the U.S. and Canadian standards are shown in the attached table. In the 1988 model year, U.S. and Canadian standards for light-duty vehicles and trucks will be numerically the same.

4. Rep. Dingell: "How long would it take to re-run the certification tests that would be required by this change for a truck or for a motor vehicle?"

General Motors expects it would take approximately ten to eleven months to re-run the certification program mandated by the change in standards proposed in H.R. 4567. This assumes no problems or unforseen delays in the program. The ten months are exclusive of the development, qualification, and hardware design efforts which must precede and occur simultaneously with the certification effort. In summary, a change in the standards is already too late for implementation in model year 1988 since some of the new, fuel efficient light-duty truck programs are already undergoing the certification process.

CHRYSLER
CORPORATION

June 16, 1986

Honorable Henry Waxman
Chairman
Subcommittee on Health and the Environment
House of Representatives
Washington, D.C. 20515

Dear Mr. Chairman:

Chrysler Motors is pleased to submit to your Subcommittee the additional information requested at the hearing on H.R. 4567 held on May 1, 1986. Attachment A contains our response to questions regarding Title II of "The Acid Deposition Control Act of 1986":

- The cost impact of H.R. 4567.
- Comments on the proposed emission standards.
- The amount industry has spent in compliance with the Clean Air Act.

We respectfully request that the attached information be included in the record established at the May 1, 1986 hearing. If Chrysler can provide any further assistance, please do not hesitate to contact us.

Sincerely,

B. I. Robertson
Director
Powertrain Engineering

BIR/ja

Attachment

P. O. BOX 1118, DETROIT, MICHIGAN 48288

ATTACHMENT A

CHRYSLER'S RESPONSE TO SUBCOMMITTEE QUESTIONS

The motor vehicle emission standards proposed in H.R. 4567 present Chrysler with difficult financial and technological challenges. The following sections elaborate on Chrysler's position regarding the cost impact of H.R. 4567, the proposed emission standards, and the overall costs of complying with the Clean Air Act.

The Impact of H.R. 4567 on the Cost of Vehicles

Chrysler has determined that the vehicle emission standards proposed in H.R. 4567 would require very significant improvements in vehicular emission control technology. The exact technology required to meet the tailpipe emission standards proposed by H.R. 4567 has not been identified. In order to facilitate estimating the cost of this additional emission control, we used the California emission packages as a base because of anticipated similarity in technology. It is estimated that the retail price of a passenger car or light-duty truck would increase as shown below to meet H.R. 4567 emission standards:

Model Year	Model	Pollutant	Emission Standard From	Emission Standard To	Retail Price Increase
1989	PC	NOx	1.0	0.7 g/mi	$99
1988	LDT	NOx	1.7	1.2 g/mi	$235*
1988	HDGE	NOx	6.0	1.7 g/bhp-hr	not feasible
1990	LDT	HC	0.8	0.41/0.53 g/mi	$235*
1988	PC & LDT	Refueling emissions	none	requirement	$85

PC = passenger car
LDT = light-duty truck
HDGE = heavy-duty gasoline engine

* same emission package

Comments on the Proposed Emission Standards

Chrysler believes that the automotive industry has already accomplished more than its share of protecting the environment by reducing motor vehicle emissions to the extent it has. It is important to note that these reductions were achieved while improving fuel efficiency almost 3% per year and at the same time delivering traditional levels of driveability and performance. If the proposed standards are implemented, the automobile industry would have to expend considerable effort, and impose additional expense and inefficiency on all Americans, without contributing any meaningful improvements to the environment. With respect to the particular standards:

- The proposed 0.7 g/mi NOx passenger car standard can not be directly compared with California's standard. Meeting 0.7 NOx with the federal 3.4 CO standard (California's CO standard is 7.0 g/mi) represents a difficult technical challenge. The fact that some engine families are presently certified at levels below 0.7 g/mi NOx and 3.4 g/mi CO does not demonstrate that these standards are technologically feasible under in-use conditions. Manufacturers must design emission control systems well-below the appropriate emission standard in order to assure that the vehicle will be in compliance with the standard during its entire useful life (50,000 miles for passenger cars and 120,000 miles for light-duty trucks, as required by EPA). The difference represents a built-in safety margin to allow for certification data car test result variability, running changes, production variations and any of the broad range of conditions to which vehicles are subjected during their useful life. Without that safety margin, large numbers of vehicles would exceed the emissions standards. Manufacturers would then be forced to recall most of their fleet, while incurring enormous expense in retrofitting these vehicles with additional emission controls.

- The proposed light-duty truck 1.2 g/mi NOx standard for 1988 is not feasible since this requirement does not provide us with sufficient leadtime for implementation. Our certification program for 1988 is already well underway. Therefore, it is too late in the engineering time schedule to make any significant modifications to the emissions control package on these vehicles.

- The proposed heavy-duty gasoline engine 1.7 g/bhp-h NOx standard is impossible to meet given current technology. In fact, certain of our heavy-duty trucks are unable to meet the current California 5.1 g/bhp-h NOx standard. With passage of this standard, consumer choice would be adversely affected due to restricted model offerings.

- The proposed light duty truck 0.41/0.53 g/mi HC standard is achievable given our best known technology, but compliance would be expensive. Therefore, we recommend that the effectiveness of this standard be reconsidered in light of the considerable cost.

- H.R. 4567 also appears to mandate nationwide gasoline refueling controls, either as an on-board system or Stage II controls at the pump. Chrysler agrees with the findings of the Health Effects Institute, whose investigation determined that there is no evidence of any health hazard to people refueling their own motor vehicles. Control of HC refueling vapors should be limited to local areas that are out of compliance with ozone requirements. The most expeditious and cost-effective means of bringing these areas into compliance is through selective regulation of gasoline volatility and Stage II gas pump controls.

Industry Expenditure to Comply with the Clean Air Act

The Clean Air Act has, for many years, had a very significant impact on the automotive industry, and Chrysler has played a key role in the auto industry's development of the emission control technology needed to meet the requirements of the Act. We have accomplished reductions of passenger car hydrocarbons by 96%, carbon monoxide also by 96%, and nitrogen oxides (which are much more difficult to control) by 75%. This has proven to be a formidable task, requiring considerable resources to solve the many technical problems that stood in the way of achieving increasingly more stringent emission standards. Control systems have evolved from calibration revisions to air injection pumps, to oxidation catalysts and unleaded fuel, to exhaust gas recirculation; and recently to computerized engine and fuel controls, exhaust oxygen sensors, new three-way cataysts, fuel injection, and so on.

Since 1967, Chrysler has incurred expenses of approximately one half billion dollars to design, develop, and produce vehicles that are in compliance with the Act. Additionally, the customer has incurred successive increases in the retail price of passenger cars amounting to almost $800 in the same time period.

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THOMAS M. RYAN, CHIEF COUNSEL

U.S. House of Representatives
Committee on Energy and Commerce
Room 2125, Rayburn House Office Building
Washington, DC 20515

June 12, 1986

Mr. Thomas Kuhn
Executive Vice President
Edison Electric Institute
1111 19th Street, N. W.
Washington, D. C. 20036

Dear Mr. Kuhn:

Thank you for your recent letter and enclosure responding to my inquiries about H.R. 4567.

As you know, H.R. 4567 has been amended. I request your views on the amended version, particularly taking into account the specific issues that relate to electric utilities discussed in the enclosed letters to the Environmental Protection Agency (EPA), the Federal Energy Regulatory Commission (FERC), and the National Association of Regulated Utility Commissioners.

Also enclosed is a copy of a letter I received from ICF, Incorporated regarding that firm's "comparative analyses" and your organizations contracts concerning H.R. 4567, along with a recent General Accounting Office (GAO) report on computer modeling and my letter to the EPA and the Chairman of the Committee on Government Operations concerning that report. I welcome your comments on these documents as well.

The ICF letter points up a concern for me and I feel certain for many Members. That concern is that we are receiving a number of analyses which all show significant annual costs for electric ratepayers under H.R. 4567, but all are quite different. In the case of the ICF and EEI analyses, ICF claims that the "major difference between the results of the two analyses is the dominant method of sulfur reduction." ICF then states:

> EEI predicts significantly more scrubbing, whereas EPA (which are those of ICF) forecasts significantly more switching to low sulfur coal. The two sets of conclusions result from a basic difference in approach.

The ICF and Electric Utilities Model used for the EPA analysis is a highly disaggregated tool for analyzing the economic choices made by utilities in response to new policies such as H.R. 4567. The EEI/-TBS approach, on the other hand, is based upon a set of generic assumptions for many important economic variables. For example, TBS assumes that the cost of low sulfur coal will rise at uniform national rates as a result of H.R. 4567. The magnitude of these increases is exogenously determined and inserted into their analysis; this means large increases in the cost of low sulfur coal are merely "assumed" in the TBS analysis. Consequently, many utilities "choosing" scrubbing in TBS' scenario "choose" fuel switching in the ICF analysis.

ICF calculates the impact of the bill on utility costs and low sulfur coal prices by employing its Coal and Electric Utilities (CEUM) (which is criticized in the GAO report). This model forecasts utility powerplant specific compliance choices (e.g., fuel switching, scrubbing, blending, dispatching changes) based on the detailed economics of these choices. The choice to consume lower sulfur coals is made interactively in light of higher prices associated with greater demand for these coals. The modelling of these choices incorporates detailed information about coal transportation costs, the costs of opening new mines, existing mine costs, coal mining productivity and several other economic factors affecting the cost of supplying coal. In addition, it incorporates detailed information regarding the amount, type and characteristics of utility powerplant capacity and the costs of operating these plants. Thus, the price of low sulfur coal is an output of the analyses, rather than an input assumption. ICF believes that this is a more powerful approach for calculating the bill's effect on low sulfur coal prices and thus on utility pollution control decisions and costs.

Also, the TBS approach is not a purely economic analysis. ICF assumes that utilities will choose among pollution control options solely on the basis of costs. TBS bases the utility pollution control decision upon noneconomic as well as economic criteria. While we agree with EEI that institutional constraints are important, TBS's methodology for incorporating such issues is based upon anecdotal information that is neither documented nor reproducible. (Underlining supplied)

Obviously, I want you to have the opportunity to tell us whether or not you agree with the ICF comments and assessment of the differences, taking into consideration the criticisms discussed by GAO regarding the ICF model. It is important, however, that whether or not you agree with ICF, that EEI explain more succinctly why utilities would choose technology over coal switching and to what extent and where the EEI analysis departs from a "purely economic analysis."

Let me stress that I have no fault with EEI for departing from a purely economic approach and including "noneconomic" criteria, such as "institutional constraints." Indeed, that, in fact, may better reflect the bill which gives the Governor, not the utility, the "flexibility" to choose the methods to achieve the required emission reductions. While I do not have trouble with the idea of giving the states the planning role, I can agree that the states are not likely to employ that authority evenly or in the same manner that might be employed by a utility. Nevertheless, it is important that EEI do more to explain where its analysis departs from economics and why. EEI should also discuss the "rate shock" and "levelization" approach and why EEI believes one is more reflective of what is likely to occur.

Additionally, I request that EEI explain in greater detail how and when coal switching will occur, particularly in light of the fact, as I understand the matter, many utilities have existing high sulfur coal contracts that will not end before 1993 or 1997. In order to switch, would these contracts have to be terminated? How will that be achieved? What are the provisions of the contracts that allow for such termination? What are the notice requirements? What are the cost impacts? What is the impact on high sulfur coal miners and operators? Will this be significant?

The Alliance for Clean Energy (ACE), in the enclosed ad, states that most SO_2 "comes from coal fired powered plants in a few midwestern states. In fact, just seven midwestern states produce more SO_2 pollution than all other states combined." ACE, of course, is opposed to the subsidy provisions of the bill and is encouraging coal switching, not fuel switching.

I welcome your comments on the ad. But I am concerned that the ad may be somewhat misleading because it implies that these states with these power plants are polluters and not in compliance with the Clean Air Act. It is my understanding that *all* states, including these seven, are in compliance with the National Ambient Air Quality Standards for SO_2 and that all states, including these seven, have spent considerable sums of money and effort to reduce SO_2 emissions to achieve compliance. Is that your understanding? Please explain.

Finally, enclosed is a copy of my letter to ACE about the availability of low sulfur coal. I would appreciate EEI responding to these matters as well.

Because it is late, I request your reply by June 17 or shortly thereafter.

With best wishes.

Sincerely,

JOHN D. DINGELL
CHAIRMAN

NINETY-NINTH CONGRESS

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U.S. House of Representatives
Committee on Energy and Commerce
Room 2125, Rayburn House Office Building
Washington, DC 20515

June 16, 1986

Mr. Charles J. DiBona
President
American Petroleum Institute
1220 L Street, N. W.
Washington, D. C. 20005

Dear Mr. DiBona:

Enclosed is a copy of my May 22 and 28, 1986 letters to the Environmental Protection Agency (EPA) concerning H.R. 4567. Also enclosed is a copy of EPA's letter of June 9, 1986 to the Subcommittee on Oversight and Investigations concerning stage II and onboard controls (which are also the subject of H.R. 4567) and a statement of the Engine Manufacturers Association on the bill.

I invite you and each of your member companies (if they so desire) to comment by not later than June 26, 1986 on each of the issues discussed in the enclosed letters that are of concern to your organization or your member companies, including the economic impact on your member firms. Your comments should also cover the matters discussed by EPA in its June 9 letter.

With best wishes.

Sincerely,

John D. Dingell

JOHN D. DINGELL
CHAIRMAN

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THOMAS M. RYAN, CHIEF COUNSEL

U.S. House of Representatives
Committee on Energy and Commerce
Room 2125, Rayburn House Office Building
Washington, DC 20515

June 16, 1986

Mr. George C. Nield
President
Automobile Importers of America
1725 Jefferson Davis Highway
Suite 1002
Arlington, Virginia 22202

Dear Mr. Nield:

Enclosed is a copy of my May 22 and 28, 1986 letters to the Environmental Protection Agency (EPA) concerning H.R. 4567. Also enclosed is a copy of EPA's letter of June 9, 1986 to the Subcommittee on Oversight and Investigations concerning stage II and onboard controls (which are also the subject of H.R. 4567) and a statement of the Engine Manufacturers Association on the bill.

I invite you and each of your member companies (if they so desire) to comment by not later than June 26, 1986 on each of the issues discussed in the enclosed letters that are of concern to your organization or your member companies, including the economic impact on your member firms. Your comments should also cover the matters discussed by EPA in its June 9 letter.

With best wishes.

Sincerely,

John D Dingell

JOHN D. DINGELL
CHAIRMAN

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THOMAS M. RYAN, CHIEF COUNSEL

U.S. House of Representatives
Committee on Energy and Commerce
Room 2125, Rayburn House Office Building
Washington, DC 20515

June 16, 1986

Mr. Thomas Hanna
President
Motor Vehicle Manufacturers
  Association
1620 Eye Street, N. W.
Suite 1000
Washington, D. C. 20006

Dear Mr. Hanna:

Enclosed is a copy of my May 22 and 28, 1986 letters to the Environmental Protection Agency (EPA) concerning H.R. 4567. Also enclosed is a copy of EPA's letter of June 9, 1986 to the Subcommittee on Oversight and Investigations concerning stage II and onboard controls (which are also the subject of H.R. 4567) and a statement of the Engine Manufacturers Association on the bill.

I invite you and each of your member companies (if they so desire) to comment by not later than June 26, 1986 on each of the issues discussed in the enclosed letters that are of concern to your organization or your member companies, including the economic impact on your member firms. Your comments should also cover the matters discussed by EPA in its June 9 letter.

With best wishes.

Sincerely,

JOHN D. DINGELL
CHAIRMAN

Mr. **Waxman**. For our next panel I would like to call forward Dr. Philip X. Masciantonio, United States Steel Corp., member company, Business Roundtable; Mr. John Quarles, chairman, clean air act project, National Environmental Development Association; Mr. Peter Sipple, manager for energy policy, the Energy Department, Air Products & Chemicals; Mr. Robert B. Peabody, president, American Iron & Steel Institute; Mr. William Marx, counsel of Industrial Boiler Owners; Dr. Walter E. Jackson, director, environmental affairs, United States Steel Corp., George T. Haymaker, Jr., executive vice president, Alumax, Inc., member of the Aluminum Association; and Mr. Russell Profozich, senior utility economist, Electric Consumer Resource Council.

Mr. **Sikorski** [presiding]. Mr. Masciantonio, do you want to begin then. As the chairman indicated, your entire statement will be inserted in the record and we ask that you summarize or keep your oral statement to 5 minutes.

STATEMENTS OF PHILIP X. MASCIANTONIO, ON BEHALF OF BUSINESS ROUNDTABLE TASK FORCE; JOHN QUARLES, CHAIRMAN, CLEAN AIR ACT PROJECT, NATIONAL ENVIRONMENTAL DEVELOPMENTAL ASSOCIATION; PETER A. SIPPLE, CHAIRMAN, NATIONAL ASSOCIATION OF MANUFACTURERS; ROBERT B. PEABODY, PRESIDENT, AMERICAN IRON & STEEL INSTITUTE; WILLIAM B. MARX, PRESIDENT, COUNCIL OF INDUSTRIAL BOILER OWNERS; WALTER E. JACKSON, DIRECTOR, ENVIRONMENTAL AFFAIRS, UNITED STATES STEEL CORP.; GEORGE T. HAYMAKER, JR., ON BEHALF OF ALUMINUM ASSOCIATION, INC.; AND RUSSELL PROFOZICH, SENIOR UTILITY ECONOMIST, ELECTRICITY CONSUMERS RESOURCE COUNCIL

Mr. **Masciantonio**. Mr. Chairman, members of the Subcommittee on Health and Environment, I am Philip Masciantonio, vice president of environmental affairs for United States Steel Corp.

I represent the Business Roundtable today which is an organization of approximately 200 major U.S. corporations represented through their chief executive officers.

The Environment Task Force of the Business Roundtable recognizes that there is a concern about acid deposition despite the lack of adequate evidence of damage or the effectiveness of proposed solutions.

Therefore, last year we retained the consulting firm of EBASCO to conduct a comprehensive review of existing literature which deals with acid deposition. The purpose of the review was to place into perspective the impact of acid deposition on the environments in Canada, the United States and West Germany.

The EBASCO review will be available in June of 1986 and we are hopeful it will aid our understanding of the acid deposition phenomena, particularly its causes and effects.

In January 1986 Canadian and the United States special envoys on the acid rain problem issued a report which would commit the United States to progress in addressing acid rain. It recommended that the United States implement a 5 year. $5 billion control program which would involve commercial demonstrations to continue research and a bilateral cooperative venture.

The President has endorsed the report and its recommendations. That report recognizes that there is significant uncertainty regarding the extent and nature of the current acid rain problem.

H.R. 4567 is a much more aggressive approach than called for by the special envoy's report. We oppose the passage of H.R. 4567. We have very serious concerns with a national commitment to expend over $100 billion without documented evidence of the causes or greater certainty of the benefits.

There are occasions when preventative action in the face of uncertainty is necessary but the facts are not supportive of such action in this case.

First, public health is not at risk and should not be an issue in discussing an acid rain program. The Clean Air Act is designed and is adequate to protect public health. National Ambient Air quality Standards for the most common pollutants, including SO_2 and NO_x have been in effect for over 10 years.

The primary standards for SO_2 and NO_x designed to protect public health are being achieved in most areas of the country except for a few urban areas where NO_x is considered nonattainment. H.R. 4567 would not change this attainment status.

Second, the cost of H.R. 4567 is exceedingly high and the benefits though not defined may never be realized. The Office of Technology Assessment estimates the cost of this bill at between $38 billion and $49 billion. The consulting firm of Temple, Barker & Sloane, Inc., estimates the cost to be $9.2 billion per year for the first 5 years of full compliance and equivalent to $5.4 billion per year annually for the next 20 years.

The benefits that must be realized to justify this cost are not defined in the bill and may not be realized. Unless the resources at risk mentioned in the Special Envoy's report are clearly identified, how can we be sure that the control strategy of H.R. 4567 will protect those resources or provide cost-effective benefits?

Third, we have time for research to develop the scientific basis for a control program. We have time to determine if there are any cause and effect relationship between emissions of SO_2 and NO_x and adverse impacts on the environment.

We have time to develop more cost-effective control strategies if needed. We have time because the emissions of sulfur dioxide, the pollutant of major concern, has been declining for 15 years and arguably will continue to decline.

Furthermore, there has been a major acid deposition program under way for more than 5 years. In just a few short years we will have 10 years of verifiable data to determine if there is a relationship among specific pollutants, atmospheric chemistry, acid deposition and environmental damages.

Finally, I would urge you to consider that the time is an ally in at least one other way, in that current industry projections indicate many of the existing stationary sources proposed for regulation are scheduled for replacement by new, clean facilities.

Rather than spend billions of dollars as called for by H.R. 4567, we should obtain substantial emission reductions at stationary sources for no incremental cost other than facilities shut down and replacement.

As you are well aware, we are competing in a world economy where very unit of cost may determine whether products are manufactured in America or are imported.

Thank you, sir.

[The prepared statement of Mr. Masciantonio follows:]

STATEMENT OF

DR. PHILIP X. MASCIANTONIO

VICE PRESIDENT-ENVIRONMENTAL AFFAIRS

UNITED STATES STEEL CORPORATION

ON BEHALF OF

THE BUSINESS ROUNDTABLE ENVIRONMENT TASK FORCE

BEFORE THE

SUBCOMMITTEE ON HEALTH AND THE ENVIRONMENT

COMMITTEE ON ENERGY AND COMMERCE

U.S. HOUSE OF REPRESENTATIVES

HEARING ON H.R. 4567 -- ACID DEPOSITION CONTROL ACT OF 1986

MAY 1, 1986

Mr. Chairman, Members of the Subcommittee on Health and the Environment, I am Dr. Philip X. Masciantonio, Vice President-Environmental Affairs for United States Steel Corporation. The Chairman of United States Steel Corporation, David M. Roderick, was invited to testify as Chairman of The Business Roundtable Environment Task Force. We thank you for that invitation and regret that Mr. Roderick could not testify today. He has asked me to give The Business Roundtable statement. The Business Roundtable is an organization of approximately 200 major U.S. corporations represented through their chief executive officers.

The Environment Task Force recognizes that there is concern about acid deposition despite the lack of adequate evidence of damage or the effectiveness of proposed solutions. Therefore, last year we retained EBASCO to conduct a comprehensive review of existing literature which deals with acid deposition. The purpose of the review was to place into perspective the impact of acid deposition on the environments in Canada, the United States and West Germany. The EBASCO review will be available in June, 1986, and we are hopeful it will aid our understanding of the acid deposition phenomena -- its causes and effects.

In January, 1986, Canadian and the U.S. Special Envoys on Acid Rain issued a report which would commit the United States to progress in addressing acid rain. It recommended that the United States implement a five year, $5 billion control technology commercial demonstration program, to continue research and bilateral cooperative ventures. The President has endorsed the report and its recommendations. That report recognizes that "there is significant uncertainty regarding the extent and nature of the current acid rain problem".

H.R. 4567 is a much more aggressive approach than called for by the Special Envoy's report. We oppose passage of H.R. 4567. We have very serious concerns with a national commitment to expend over $100 billion without documented evidence of the causes or greater certainty of the benefits. There are occasions when preventative action in the face of uncertainty is necessary, but the facts are not supportive of such action in this case.

First, public health is not at risk and should not be an issue in discussing an acid rain program. The Clean Air Act is designed and is adequate to protect public health. National Ambient Air Quality Standards for the most common pollutants, including SO2 and NOX have been in effect for over ten years. The primary standards for SO2 and NOX, designed to protect public health, are being achieved in most areas of the country, except for a few urban areas where NOX is considered nonattainment. H.R. 4567 would not change this attainment status.

Second, the cost of H.R. 4567 is exceedingly high and the benefits, though not defined, may never be realized. The Office of Technology Assessment estimates the cost of this bill at between $38 and $49 billion. The consulting firm of Temple, Barker and Sloane, Inc. estimates the cost to be $9.2 billion per year for the first five years of full compliance (1997-2001) and equivalent to $5.4 billion per year annually for the next 20 years. The benefits that must be realized to justify this cost are not defined in the bill and may not be realized. Unless the "resources at risk" mentioned in the Special Envoy's report are clearly identified, how can we be sure that the control strategy of H.R. 4567 will protect those resources or provide cost effective benefits?

Third, we have time for research to develop the scientific basis for a control program. We have time to determine if there are any cause and effect relationships between emissions of SO2 and NOX and adverse impacts on the environment. We have time to develop more cost effective control strategies if needed. We have time because the emissions of sulfur dioxide, the pollutant of major concern, has been declining for 15 years and arguably will continue to decline. We have time because there has been a major ten year acid deposition program under way for more than five years. In just a few short years, we will have ten years of verifiable data to determine if there is a relationship among specific pollutants, atmospheric chemistry, acid deposition and environmental damages.

Finally, I would urge you to consider that time is an ally in at least one other way -- that current industry projections indicate many of the existing stationary sources proposed for regulation are scheduled for replacement by new, "clean" facilities. Rather than spend billions of dollars as called for by H.R. 4567, we should obtain substantial emission reductions at stationary sources for no incremental cost other than facilities shut down and replacement.

As you are well aware, we are competing in a world economy where every unit of cost may determine whether products are manufactured in America or are imported. H.R. 4567 will increase the cost of virtually every product manufactured in the United States, and we cannot be certain we are buying any real evironmental benefit in exchange for that cost. We urge the Subcommittee to very carefully consider the need for H.R. 4567. Thank you for the opportunity to present our views.

Mr. Sikorski. Thank you, Mr. Masciantonio.
Mr. Quarles.

STATEMENT OF JOHN QUARLES

Mr. Quarles. Mr. Chairman, I appreciate the opportunity to testify on H.R. 4567 on behalf of NEDA/CAAP. Since my time is extremely limited, let me immediately state the major concern that companies and labor unions of NEDA/CAAP have with regard to this bill which is that it is in our judgment wholly inappropriate to be rushing through this bill on the schedule that has been suggested in view of the fact that it brings under the proposed regulatory orbit a whole new range of facilities that have not been part of the acid rain debate before now.

There are four features of this bill that in combination dramatically expand the scope of its coverage and what I want to do is to indicate what those features are at the outset.

First, this bill unlike other acid rain bills before which all concentrated primarily if not entirely on sulfur oxides, this bill expands the scope of coverage to nitrogen oxides.

Second, this bill expands the regulatory controls to all 50 States.

Third, the bill expands the coverage in a much more substantial way to automotive sources and trucks.

Fourth, the bill imposes new controls on industrial boilers and industrial process operations.

It is that last item that I am going to concentrate on mainly in my testimony. The coverage of the bill on industrial boilers and industrial process operations in all 50 States and with respect to the NO_x requirements means that you brought new operations under the proposed regulatory controls and really nobody knows what sources those are, how many of them there are, what the costs would be of control, how severe the impacts would be.

In addition, nobody really knows what benefits would result from the costs and burdens that the bill would impose in this sector because they have not heretofore been considered a significant part of the debate over acid rain and there has never been much of a suggestion that they have figured prominently in the acid rain formation problem.

Now section 1982 of the bill is the provision that imposes the controls on industrial boilers and it would require that by January 1, 1997, the industrial boilers meet the standards of 1.2 pounds per million Btu for sulfur dioxide and 0.6 pounds per million Btu of heat input for NO_x.

Those are the same standards that would apply to the utility boilers. I think there will be a lot of questions raised about applying those standards to utility boilers but with regard to the industrial boilers, there are even more questions.

One of the problems that concerns us is that the way the bill is structured from an administrative viewpoint, we anticipate that every single source will be required to meet those standards because I don't believe the statewide averaging arrangements are going to be accomplished by States through plans.

In particular, there is not time for EPA to approve State plans if they are submitted by the deadline of June 1994.

In addition, there is a special problem that applies to industrial sources of curtailing their fuel selection flexibility. Most boilers have got the flexibility today to use either coal or oil or to use oil or natural gas or maybe all three.

The allowable emissions that currently apply set ceilings that hit those individual sources but if there is imposed the requirement of the specific standards that are set in the bill, then every source will have to meet those and not every source can meet those without putting in very expensive control equipment now even though much of the time the source might be using the oil or even especially the natural gas fuel that would not be causing an emission problem.

So they would have to put in the controls for the dirtier fuel even though they often might use the cleaner fuel and that problem is more severe for industrial boilers than it is for utility boilers and again, that hits the question of what are the benefits.

Even of greater concern perhaps are the provisions of section 183 of the bill which would impose requirements on industrial process operations and there is no indication what those would be beyond that they must be whatever the Administrator determines to be technically and economically feasible.

There are extremely expensive controls that could be forced onto these facilities with very little benefit. In short, what is happening under the bill is that it is bringing under this new program a whole new universe of sources that have not heretofore been part of the acid rain debate and for that reason it is inappropriate to be moving ahead on such a fast schedule with these very limited hearings and markup beginning almost immediately.

[Testimony resumes on p. 201.]

[The prepared statement of Mr. Quarles follows:]

NEDA
CAAP
CLEAN AIR ACT PROJECT
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JOHN QUARLES Project Chairman

Statement of

John Quarles, Chairman
National Environment Development Association
Clean Air Act Project

Before the
Subcommittee on Health and the Environment
of the
Committee on Energy and Commerce
House of Representatives

May 1, 1986

Mr. Chairman and Members of the Committee:

I appreciate the opportunity to appear before you today to testify on behalf of the National Environmental Development Association's Clean Air Act Project, NEDA/CAAP, with respect to H.R. 4567, a proposed amendment to the Clean Air Act.

NEDA/CAAP's members -- large national corporations and the labor unions of the Building and Construction Trades Department of the AFL-CIO -- remain committed to constructive modifications in the Clean Air Act which will improve the efficiency of the national effort to achieve and preserve clean air and which will reduce unwarranted burdens on economic vitality and remove unnecessary obstacles to industrial growth.

Two years ago I testified for NEDA/CAAP that Congress must not consider acid rain legislation alone, but only as part of the Clean Air Act. Today that position is even more valid than it was two years ago.

H.R. 4567 reaches into and raises questions about more programs in the existing Act than the legislation this sub- committee had under consideration two years ago. It affects far more sources -- potentially every industrial source in the country. Yet this bill fails to confront numerous other Clean Air Act issues that are begging for your consideration and resolution.

Precipitous Action Would Be Unwise

H.R. 4567 proposes an ambitious program of new controls on utility boilers, industrial boilers and industrial process emissions. In seeking to control such a wide range of sources, it goes far beyond previous proposals for acid rain controls in terms of the depth and breadth of its impacts on American industry, employment and the public at large. In light of this radical expansion of scope of the previous debate over acid rain controls, NEDA/CAAP is dismayed at the schedule that has been proposed for congressional consideration of this bill and its impacts. NEDA/CAAP urges that the effects of this bill be carefully evaluated and fully debated before this bill is reported.

Although we have not had adequate time to evaluate all of the probable effects of this bill, we note the following reasons to proceed with extreme caution:

- The controls proposed by the bill would impose burdens which will fall disproportionately on many sectors of American industry, which have little to do with acid rain formation.

- The bill does not contain a mechanism for integrating these new controls into the existing structure of the Clean Air Act. This bill will create redundancies with, or make meaningless, traditional programs for the control of sulfates and oxides of nitrogen.
- The bill does not address at all a large number of other major issues which have figured prominently in most predecessor proposals to improve the Clean Air Act. Some of these are issues that require near-term congressional consideration and resolution.

H.R. 4567 Will Have Widespread Effects on Jobs and Industry

It is difficult to be specific about the effects on industry, but NEDA/CAAP believes they will be major and adverse, both in their aggregate cost and in the wide range of industries that will be affected. While Section 183 leaves it to EPA and the states to determine, the actual scope and level of industrial boiler and process controls, it is clear that the bill expands the scope of acid rain controls from utility boilers to potentially every manufacturing plant in the country.

The potential impacts of all of the requirements of H.R. 4567 are stunning. In financial terms alone, certain estimates indicate that the cost of compliance with the provisions of this bill would total $40 billion. Other estimates range up to $90 billion. Even the higher estimate does not include the full potential costs of industrial boiler and industrial process controls. Whatever the true figure may be, it seems apparent that this bill carries a price tag that dwarfs all other pieces of environmental legislation previously enacted by Congress, including even the Superfund -- and including even the most ambitious proposals for that law's expansion.

Four major elements of the bill are primarily responsible for our deep concern about the impacts of the bill on jobs and industry:

- H.R. 4567 would expand the coverage of proposed controls for acid rain from sulfur dioxide to include nitrogen oxides and hydrocarbons.
- The bill would extend the coverage of SO_2 and No_x controls to the businesses and utilities of all 50 states, including Hawaii and Alaska.
- The bill would greatly increase the cost, impacts on performance and difficulty of complying with automobile and truck emission controls.
- The bill establishes a major new focus on industrial boilers and a broad range of other industrial process operations without an assessment of the need for such controls.

Each of these elements of expansion is individually important. It is, however, the combination of these elements which has the most dramatic and far-reaching significance. For example, nitrogen oxide emissions from industrial process facilities in Iowa, Kansas, Utah or Wyoming would be subjected to costly controls under the provisions of H.R. 4567, despite the fact that they contribute little, if anything to the acid rain problem and these controls would not be needed to meet these states' air quality goals. The bill also does not cite emission reduction targets for industrial facilities, nor is it accompanied by an assessment of costs. Indeed, it appears that the data are not available which would be needed to indicate how many of such sources would be affected, what the cost impacts would be, or what benefits would result from such controls. EPA's inventories of the industrial sources of sulfateand oxides of nitrogen emissions are sketchy at best. Yet, these provisions raise a whole host of new questions. The proposed schedule of hurry-up hearings and immediate mark-up -- which may be likened to a no-huddles, two-minute offense -- will give no chance to get answers to those questions.

Analysis of Sections 182 and 183

Before proceeding to discuss further these impacts, I wish to highlight two sections H.R. 4567 which create these concerns. The first is section 182, which would require every state to establish a new set of regulatory controls applicable to industrial boilers. By January 1, 1997, average SO_2 emissions would have to be limited to 1.2 pounds per million Btu of heat input. By the same date, NO_x emissions would have to be controlled to an average of 0.6 pounds per million Btu of heat input. Serious questions exist of the ability to technically meet these limits.

If states fail to establish such requirements and obtain approval of their plans by EPA prior to specified deadlines, then every industrial boiler would be required to comply individually with those emission rate limitations. This is not idle speculation. EPA cannot meet the deadline in the bill. (EPA's Region V schedules 14 months for state implementation plan amendments and frequently misses its own deadline -- and that is in a mature and well understood program!) The specified emission levels are comparable to those proposed for application to utility boilers. Serious questions exist whether such requirements would make sense with respect to utility boilers -- especially in all 50 states -- but even greater questions arise with respect to industrial boilers. They are a far more diversified group of facilities and include units of much smaller size, where the relative costs are far heavier in relationship to the benefits.

These requirements for state plans to control emissions from industrial boilers raise many questions. One serious question concerns the effect on existing arrangements which allow industrial facilities flexibility to switch fuels in response to market forces, fuel supply disruptions or uncertainties and other considerations. Most industrial boilers have air permits which allow an emission rate high enough so they can switch between coal and oil or between oil and natural gas (or in some instances shifts between coal and natural gas). Since many facilities are not burning the fuel with the highest emissions at any given time, normal "actual" emissions are typically far below "allowable" emissions. H.R. 4567 may force states to limit permits to something less than the levels that can be met with higher emission fuels without new or additional controls. This would take away the flexibility to switch fuels and force companies to make permanent choices of specific fuels. To protect themselves from price changes or supply problems, many facilities would opt for high-emission, but economically safe fuels. This pattern of state regulatory decisions and responses by the sources may mean virtually every source, even those which commonly burn clean natural gas, will have to install new or additional controls. These disruptive impacts are likely to be far more severe for industrial boilers than comparable impacts on utility boilers, even though the air quality benefits will be less.

In addition to these new controls on industrial boilers, section 183 would impose further requirements for reductions in SO_2 and NO_x emissions from all "industrial process" facilities. That section establishes a standard that such sources must reduce emissions to the full extent that they are "economically and technically achievable by December 31, 1996." It must be stated immediately that advances in technology have developed methods by which these emissions can -- at extraordinary cost -- be dramatically reduced in many instances. Such "technically achievable" controls may not be achievable in realistic economic terms. However, it is not clear what the bill means by "economically achievable." No guidance is provided as to what standard should be applied to determine what is "economically achievable." Is this essentially an affordability test? Does it mean that a company would be required to install controls unless the cost would force bankruptcy? Can reasonable projections of foreign competition, the need for funds for modernization or expansion, etc. be considered? Can the economic achievability of the technology be determined on a plant-specific rather than industrywide basis? Again, we face the haunting question of how many industrial facilities throughout this country might be severely hurt by these new requirements, where are they located, and what benefits would accrue to justify the likely economic and burdens.

Additional Sources that Would Be Subject to New Controls

This analysis demonstrates that H.R. 4567 brings into the acid rain debate a whole new universe of industrial boilers and industrial processes that have not heretofore had to face the possibility of such controls. The managers and employees of these facilities typically today rest in naive ignorance of what is about to befall them. They have no idea of the regulatory surprise -- and hardship -- which may loom ahead. Even if they could determine the level of control that the bill would require, given the lack of specificity in H.R. 4567, there are not enough data currently available to determine which industries might be affected by controls, which plants closures might be forced, or how many jobs might be affected.

Nevertheless, to give a practical indication of the types of industrial facilities that may be affected, we have made some educated guesses of some of the types of facilities which may face controls under this bill:

- Facilities producing ethanol from grain or methanol from biomass
- Natural gas processing plants
- Refineries
- Offshore oil and gas exploration and production facilities
- Enhanced oil recovery steam generation facilities
- Cokers, calciners and drying plants
- Chemical plants
- Metal ore smelting, refining or processing plants
- Metal rolling and finishing plants
- Glass making plants
- Hazardous waste incinerators

- Thermal drying units for coal processing
- Cement plants
- Incinerators
- Flour mills
- Biomass industrial boilers
- Gas turbines
- Paper making

Most of these facilities have installed controls to address their significant air emissions. This bill would call for a whole new round of controls in the name of acid rain, even though it has seldom been suggested, and never demonstrated, that these facilities have anything to do with acid rain, particularly if they are located in the Western part of the country.

Members of the Environmental and Health Subcommittee should note that many of these facilities will be paying for H.R. 4567's new programs twice: once in increased cost of power due to the control requirements for utilities and again in the capital and operating cost of their own controls. In many cases, their ability to compete with foreign producers and their ability to pass along these costs will be extremely limited.

The Bill's New Mobile Source Controls Would Present Major Problems

The makers of automobiles and trucks will be testifying on the technical difficulties they would face if H.R. 4567's exhaust emission controls were enacted. However, NEDA/CAAP also wants to register its opposition to these provisions. These controls have implications for fuel economy, performance, cost and the difficulty of meeting the existing standards for performance, cost and the difficulty of meeting the existing standards for other pollutants. These adverse impacts on the industry and the public are not warranted by any demonstrated contribution of mobile source emissions to the acid rain problem.

Acid Rain Legislation Must Accompany Broader Consideration of the Clean Air Act

NEDA/CAAP contends that it is inappropriate for Congress to amend the Clean Air Act in a manner which addresses only the acid rain issue. Many other Clean Air Act problems have an equal claim on congressional attention and present just as urgent a need for statutory change. The new source review requirements are an extraordinarily complex, burdensome and time-consuming set of procedures which obstruct the construction and expansion of industrial facilities in this country and retard the creation of new jobs. The deadlines imposed by the Act generate confusion and potential trouble--with the final deadline for compliance of July 1, 1987, fast approaching, a prospect exists that widespread imposition of construction moratoriums will disrupt normal patterns of economic growth, wrecking havoc throughout the construction industry in numerous localities. The potential for ever more rigorous control of older facilities puts many of them in real jeopardy.

If the Clean Air is opened up to amendment, these and other critical features of the current statute also need to be reviewed so that appropriate modifications can be made.

If changes to the statute are made to impose new "acid rain" controls, an equally strong argument exists that adjustments should simultaneously be made in those parts of the current regulatory framework that are directly affected by the new provisions. In particular, if Congress should adopt a program designed to drive down sulfur dioxide emissions across the country, the justification for continuing to enforce sulfur dioxide PSD requirements in "Class II" areas is destroyed. EPA has also recently been sued in the Northern District of California to force the creation of a PSD program for oxides of nitrogen. Should such a program be forced by the current language of the Act, it too would be affected by H.R. 4567's NO_x controls. The usefulness of such a PSD program for NO_x (or any of the Set II pollutants) is highly questionable in any event, but Congress certainly should repeal the existing requirement (section 166 of the Clean Air Act), in light of the NO_x controls in H.R. 4567.

In short, NEDA/CAAP urges that any approach to amendment of the Clean Air Act should allow an even-handed consideration of the merits of all major pending proposed modifications to the statute.

H.R. 4567 Must Not Be Considered in Haste or Passed in its Current Form

We urge the subcommittee to defer action on this bill -- and specifically that it postpone any proposed immediate mark-up -- until a fair opportunity has been provided for the effects of the bill to be understood

and fairly communicated to those who may be affected. That much is required as a simple matter of due process of law.

Conclusion

In conclusion, NEDA/CAAP must strenuously oppose the passage of H.R. 4567 at this time. Given the magnitude of the potential effects, it is notable that nowhere is there a finding in this bill that the contribution of emissions from industrial and mobile sources contributes significantly to acid precipitation. We are extremely troubled by the combination of the content of the bill and the stated intentions of the Chairman to rush this bill through Subcommittee mark-up without providing an adequate opportunity for evaluation and debate. Although the subject of acid rain is certainly not new, this bill -- in contrast to prior acid rain proposals -- drastically expands the scope of those who would be affected by the proposed regulatory controls and raises many novel issues only a few of which have I been able to touch on in my testimony. It is wholly inappropriate that a bill proposing such far-reaching and unexamined impacts be sprung on the Congress and rushed through mark-up without providing adequate time to identify and evaluate the effects and potential benefits of the bill. The sponsors of this legislation must be required to give adequate answers to the piercing questions their proposals clearly present.

Mr. Sikorski. Thank you, Mr. Quarles.
Mr. Sipple.

STATEMENT OF PETER A. SIPPLE

Mr. Sipple. Thank you, Mr. Chairman, and members of the subcommittee. My name is Peter Sipple and I am manager of energy policy for Air Products & Chemicals in Allentown, PA. I speak here this morning on behalf of the National Association of Manufacturers and I serve as the chairman of the National Association of Manufacturers' Task Force on Electricity and also as chairman of its Clean Coal Technology Task Force.

NAM as I am sure you know is a voluntary business association of over 13,500 corporations, large and small, located in every State in the Nation. NAM member companies employ 85 percent of all workers in the manufacturing sector and produce over 80 percent of the Nation's manufactured goods.

NAM is strongly opposed to H.R. 4567 because we believe there is uncertainty with regard to the current dimensions of the problem; there is uncertainty with regard to the direction and rate of change; and there is uncertainty with regard to the mitigating effects of the proposed remedial measures.

We do not believe that it would be in the best interest of the nation to adopt the amendments to the Clean Air Act contained in this bill, especially when studies strongly indicate that significant emissions reductions are occurring.

We believe the significant facts germane to our position are these. One, SO_2 emissions have reduced by 28 percent between 1973 and 1983 despite a 60-percent increase in coal usage for power generation purposes.

These gains arise from the impact of the existing Clean Air Act and these gains are continuing. Clean Air Act expenditures since 1970 are estimated to be approximately $75 billion and are now running at an annual rate of $10 billion per year.

Two, there is significant public and private sector commitment to clean coal technology development. This commitment is expected to yield more cost-effective methods of dealing with the problems associated with coal use.

Three, the economic burden of an arbitrarily determined additional emissions reduction program will weigh heavily on the U.S. economy. Cost increase forecasts range from OTA's low estimate of $3.8 billion per year to the Edison Electric Institute estimate for the first year expenditure of $9.2 billion. Whatever the correct figure, it will cost the United States billions of dollars to produce the same amount of goods and services.

The result of this additional expenditure will be a severely handicapped competitive position in world markets for the United States with a correspondingly negative impact on U.S. jobs.

Four, the bill recognizes the potential for substantial cost impact on consumers and seeks to employ an acid deposition control fund as a means of capping of electric rate increases.

This nationally applied fee is flawed because: First, it fails to address the significant cost components of the bill; second, it represents a subsidy of residential consumers at the expense of the industrial commercial sector; and third, we believe it risks a potentially unconstitutional delegation of legislative authority to the executive branch of Government.

For all of these reasons which are more fully developed in our written testimony, NAM urges that H.R. 4567 be withdrawn. This type of legislation is not merely air pollution control but carries with it many economic consequences and dislocations in terms of labor, manufacturing plant siting, industrial growth and competitiveness and finally, international trade.

The facts are that American industry has spent and is spending billions of dollars annually in a sincere effort to improve air emissions from manufacturing and power generating facilities. As a result, air quality has and is improving. The Clean Air Act does not need the amendments proposed by H.R. 4567.

Thank you, Mr. Chairman.

[The prepared statement of Mr. Sipple follows:]

TESTIMONY OF
NATIONAL ASSOCIATION OF MANUFACTURERS

BY
PETER A. SIPPLE
MANAGER - ENERGY POLICY
AIR PRODUCTS & CHEMICALS, INC.

H.R. 4567, "ACID DEPOSITION CONTROL ACT OF 1986"
BEFORE THE
SUBCOMMITTEE ON HEALTH AND THE ENVIRONMENT
COMMITTEE ON ENERGY AND COMMERCE
UNITED STATES HOUSE OF REPRESENTATIVES

MAY 1, 1986

Mr. Chairman and Members of the Subcommittee, I am Peter Sipple, Manager of Energy Policy for Air Products and Chemicals, Inc. and Chairman of the National Association of Manufacturers (NAM) Task Force on Electricity, as well as the Chairman of the Clean Coal Technology Task Force. I appreciate the opportunity to present our views on H.R. 4567, the proposed "Acid Deposition Control Act of 1986."

NAM is a voluntary business association of over 13,500 corporations, large and small, located in every state. Members range in size from the very large to over 9,000 smaller manufacturing firms, each with an employee base of less than 500. NAM member companies employ 85 percent of all workers in manufacturing and produce over 80 percent of the nation's manufactured goods. NAM is affiliated with an additional 158,000 businesses through its Association Council and the National Industrial Council.

NAM is strongly opposed to H.R. 4567 because we believe there is uncertainty with regard to the current dimensions of the problem; uncertainty with regard to the direction and rate of change; and uncertainty with regard to the mitigating effects of proposed remedial measures. We do not believe it would be in the best interest of the nation to adopt the amendments to the Clean Air Act contained in this bill, especially when studies strongly indicate that significant emissions reductions are occuring.

Positive Historical Trend

Between 1973 and 1983, the U.S. achieved an appreciable 28 percent decline in SO_2 emissions. While SO_2 emissions have declined by this amount, the tonnage of coal burned to generate electricity in this country has steadily risen some 60 percent from 389 million tons in 1973 to 737 million tons in 1983, and to 693 million tons in 1985. National average emission rates at coal-fired electric utility plants in particular have decreased by 46 percent from 4.01 pounds per million BTUs of heat input in 1973 to 2.15 pounds per million BTUs in 1985. All but a comparatively few areas in the country have attained the National Ambient Air Quality Standards for sulfur oxides.

These SO_2 reductions have come about at substantial cost to society. Since passage of the Clean Air Act in 1970, the United States has spent an estimated $75 billion to control SO_2 and NO_x. Electric utilities alone, spent some $42 billion in the 1970s and

are now spending about $10 billion per year. Amendments to the Clean Air Act adopted in 1977 require scrubbers or other control technology yielding equal or better removal efficiency to be installed on all new coal-burning power plants. One hundred twenty-six scrubbers are currently operating in the United States on over 47,000 megawatts of coal-fired, electricity-generating capacity, and another 88 scrubbers are in the planning or construction phase.

Diversity of Financial Committment

Furthermore, significant resources are already being committed to develop new technologies to curb SO_2 emissions. The Energy Department's Fossil Energy Research and Development program and the Clean Coal Technology program are this year alone budgeted for $345 million. Private industry is also intensively pursuing projects to gain greater knowledge about detailed characterizations of specific coals and the cost-effectiveness of various methods of preparing each type of coal prior to combustion. NAM believes these efforts should be supported and encouraged.

The Electric Power Research Institute's (EPRI) expenditures over its ten-year existence total $1.5 billion. About 30 percent of this work has focused on understanding and reducing the environmental impact of using coal.

It is also important to note State efforts. In Wisconsin, the Wisconsin Electric Power Company is proposing to implement a $600 million program to achieve significant emission reductions. The state of Ohio is spending approximately $100 million and the state of Illinois approximately $65 million on clean coal technology.

In light of this progress, it does not appear cost-effective to mandate the additional expenditure of billions of dollars to reduce emissions by an additional arbitrarily determined amount.

Cost Impact to the Economy

Energy is the life blood of manufacturing. H.R. 4567 will impose large costs on manufacturing both through higher prices for electricity and through costs imposed directly on industrial boilers and industrial processes. Enterprises which will be compelled to commit billions in capital investment will also be required to expend additional billions in operating and maintenance costs annually. In pollution control, the ratio of operating and maintenance costs to capital costs varies from sector to sector, but it is substantial in each instance.

Estimates of the cost of H.R. 4567 vary widely. The Office of Technology Assessment estimates the cost of H.R. 4567 at $3.8 to $4.9 billion annually by the early 1990's. The Edison Electric Institute estimates ~~annual~~ compliance costs at $9.2 billion ~~per~~ in the first year, and $110 billion (in 1986 constant dollars) through the first 15 years of the program and there is no guarantee of even limited success of this costly experiment.

Obviously, if it costs the United States billions of dollars more to produce the same amount of goods, this will be a severe handicap in competition in the world market.

The bill recognizes that there will be substantial impacts on ratepayers, but its effort to ameliorate this is of highly questionable effectiveness, equity and even constitutionality. The EPA Administrator would be authorized to set a nationwide tax of not more than 1/2 mill per kilowatt hour of electricity generated to make reimbursements of interest costs of pollution control loans. Levying of taxes is a legislative function reserved to the Congress, and a delegation of this function to an officer of the Executive Branch may be an unconstitutional delegation of legislative power.

The interest subsidy program proposed by H.R. 4567 offers little prospect of relief. As proposed, subsidy payments are "...to ensure that no monthly residential customer rate payment will exceed by more than 10 percent the monthly rate payment which would have been required if no qualified pollution control debt were incurred by the utility." Since the subsidy covers pollution control debt service costs, not incremental pollution control costs, the major expenses arising from fuel switching, increased transportation costs, and operating costs are apparently ineligible for subsidization.

Though there has been discussion of modifying this language to ensure a genuine 10% rate increase cap, we are skeptical that the proposed 1/2 mill per killowatt hour excise tax limit is sufficient to generate adequate financing for real relief. Effective rate relief for heavily impacted regions will likely require a multiplication of the effective tax rate. In the meantime, pending clarification or modification of this provision, ratepayers in those areas of the country which rely heavily on coal-fired power plants could face dramatic electric rate increases.

Cross-Class Subsidization

NAM also notes with dismay that the proposed section 187 subsidy program is tied to residential rate relief. As it is now drawn, the bill would appear to exclude commercial and industrial ratepayers from eligibility for subsidy. This is plainly inequitable. If there is to be an electric rate subsidy program and if industrial and commercial firms are to pay their proportional share of any electricity excise tax, they should not be arbitrarily excluded from any potential benefit. NAM opposes discriminatory pricing schemes designed to shift a disproportionate share of regulatory costs to industry.

Reports prepared by Electric Consumers Resource Council (ELCON) indicate that the industrial ratepayers are already subsidizing residential consumers by $2.75 billion dollars annually. The additional burdens placed upon the industrial and commercial ratepayers under the provisions of this bill would only add to this subsidization penalty with a corresponding negative impact on U.S. jobs and U.S. international competitiveness in foreign trade.

Direct Industrial Cost

Although the bulk of the cost of H.R. 4567 is to be borne by electric ratepayers, heavy costs are imposed on other sectors with little prospect of environmental gain. Without any provision for a cost effective size threshold, existing industrial boilers would be required, on the average, to meet utility standards by 1997. The average industrial boiler is one-thirtyfifth the size of the average utility boiler. The control costs per ton of SO_2 removed range from three to four times higher for industrial boilers. OTA estimates that bringing industrial boilers into compliance with utility standards would produce no net reduction in NO_x emissions.

In conclusion, prudence does not mean inaction. The Clean Air Act has achieved significant emissions reductions over the last decade. Further progress will be achieved as our technologies are perfected. These improvements have and will continue as

state-of-the-art control technologies, combustion techniques, and pre-combustion fuel treatment techniques are employed. Forced accellerated application of added emissions controls will impose massive costs with little demonstrable prospect of environmental gain beyond that already being achieved.

At a time of huge trade deficits, it is particularly unwise to burden our economy with additional production costs of such great magnitude. Electricity is the life blood of the manufacturing industry, which is the largest single consumer of electricity. H.R. 4567 would not only increase the capital and operating costs of generating electricity, but would also levy a tax on its production.

This type of legislation is not merely air pollution control but carries with it many economic impacts and dislocations in terms of labor, manufacturing plant location, industrial growth, industrial competitiveness and international trade. U.S. industry has spent and is spending billions of dollars on controlling air emissions from manufacturing and power-generating facilities. As a result, air quality has and is improving. The Clean Air Act does not need the amendments proposed by H.R. 4567.

Again, Mr. Chairman, NAM appreciates this opportunity to testify. I would be glad to answer any questions you and the other Members of the Committee may have.

Mr. SIKORSKI. Thank you, Mr. Sipple.
Mr. Peabody.

STATEMENT OF ROBERT B. PEABODY

Mr. PEABODY. Thank you, Mr. Chairman. I am Robert B. Peabody, president of the American Iron & Steel Institute, a trade association representing approximately 80 percent of the steel production capability in the United States.

I present these comments relative to H.R. 4567 because that act can affect the serious, worldwide competitive situation in which the American steel industry currently struggles.

In previous testimony before this committee, we stressed the uncertainty of any direct linkage between the control of sulfur oxide emissions and any measurable reductions in acid deposition and in the effects of acid precipitation.

We believe that uncertainty continues today. The joint report of the Special Envoys on Acid Rain concluded and I quote:

> The U.S. Government carried out a thorough review of the current status of acid rain knowledge and the options available for its management. From that review, the United States concluded that, although it was clear that acid rain was a serious concern both in the United States and Canada, it lacked the information needed to make a prudent decision on the need for or design of additional emission controls.

Given this uncertainty, our major concern is with the economic costs entailed in H.R. 4567. The steel industry faces a financial crisis. The industry has just concluded its fourth year of staggering cumulative losses. The net losses from 1982 through 1985 in steel operations amount to about $6.5 billion. The total industry debt is close to $8 billion.

Industry investment in plant and equipment has slipped badly due to rapidly mounting debt and the cumulative effect of losses. During the period 1982 through 1984, industry expenditures of $5.3 billion for improvements to plants and equipment exceeded y 300 percent the net cash of $1.3 billion generated from operations.

There is little cash or borrowing capability left in the industry at a time when expenditures for modernization are critically important.

Our industry has reduced capacity in an amount roughly equal to the British and Canadian steel industries combined but it desperately needs investment funds to modernize the capacity that remains.

Public policies have a direct effect on how much steel capacity will remain in this country and how modern that capacity will be. It is within that framework that we have looked at the potential costs of H.R. 4567.

H.R. 4567 will impose additional costs on the steel industry in several ways. A major cost will be imposed by the requirement that utilities reduce sulfur oxide emissions. The Office of Technology Assessment estimates the bill will increase utility costs $3.4 billion to $4.3 billion per year nationwide.

These electricity costs would vary significantly by State. For the five leading steel production states, OTA's estimates would indicate a weighted average 6.9 percent in electricity costs to residential consumers.

Since proportionately more of the costs to residential consumers is in distribution rather than the generation costs increased by H.R. 4567, correcting for this factor makes it clear that the steel industry's electricity rates would be increased by a minimum of 10 percent.

A 10-percent increase in electricity costs would add about $200 million to our annual production costs.

In addition, H.R. 4567 would require reductions in sulfur oxide emissions from industrial processes. While specific limitations are not defined, the bill will require all reductions economically and technically achievable.

Sulfur oxide emissions from many steel operations are already controlled by existing State implementation plans to the extent that they account for less than 1 percent of the Nation's SO_2 emissions.

Many other sources, however, are not controlled because the States have determined that they need not to be controlled to achieve the national ambient air quality standards.

In other words, those controls required by H.R. 4567 are not necessary to comply with the Clean Air Act.

AISI estimates that H.R. 4567 could impose on our industry capital costs of $300 million plus operating and maintenance costs of $100 million per year over and above the costs imposed by the existing Clean Air Act.

In the context of the staggering losses of the steel industry in recent years, an increase in annual operating costs of $300 million can only aggravate our serous situation.

Because of the high costs involved and the uncertain and conflicting scientific evidence regarding the cause of the acid rain problem, we strongly oppose the passage of the bill.

[The prepared statement of Mr. Peabody follows:]

Testimony

of

Robert B. Peabody

President

American Iron and Steel Institute

My name is Robert B. Peabody. I am President of the American Iron and Steel Institute, a trade association whose 48 domestic member companies account for approximately 80 percent of the steel production capability in the United States. I would like to present these comments relative to H.R. 4567, the Acid Deposition Control Act, because that act can affect the serious, worldwide competitive situation in which the American steel industry currently struggles.

AISI witnesses have previously testified before this committee relative to the acid rain bills then being considered. At that time, we stressed the uncertainty of any direct linkage between the control of emissions of sulfur oxide and any measurable reductions in acid deposition per se and in the effects of acid precipitation. We believe that uncertainty continues today. In his transmittal letter of the Joint Report of the Special Envoys on Acid Rain, United States Special Envoy Drew Lewis concluded:

> . . . There is a significant uncertainty regarding the extent and nature of the current acid rain problem. We are unsure of the size and significance of the ecological and economic losses now being experienced. We don't know what possible future damage may result if emissions continue at the current rate. These uncertainties make it even more difficult to estimate with confidence how much any emission reduction would help protect resources at risk in either country.

The report itself goes on to say:

> In the summer and fall of 1983, the U.S. government carried out a thorough review of the current status of acid rain knowledge and the options available for its management. From that review, the United States concluded that, although it was clear that acid rain was a serious concern both in the

United States and Canada, it lacked the information needed to make a prudent decision on the need for or design of additional emission controls.

Given this uncertainty, the major concern of the steel industry is with the economic costs entailed in H.R. 4567. The steel industry now faces a financial crisis. Total industry debt is close to $8 billion, and the industry's debt to equity ratio has risen from 42% in 1981 to 86.2% in 1984. The industry has just concluded its fourth year of staggering cumulative losses. The industry's net losses from 1982 through 1985 in its steel operations amount to about $6.5 billion.

Industry investment in plant and equipment has slipped badly due to the pressure of rapidly mounting debt and the cumulative effect of losses. During 1982-1984, industry expenditures of $5.3 billion for improvements to plants and equipment exceeded by 300% the net cash of $1.3 billion generated from operations. There is little cash or borrowing capability left in the industry at a time when expenditures for modernization are critically important. Simply put, most steel companies are not able to generate sufficient cash from steel operations to meet expenses. Steel companies have been drawing upon accumulated reserves just to continue operating. These reserves are being depleted rapidly.

The industry's capability to produce raw steel has declined 20%, from approximately 160 million net tons in 1977 to 128 million tons in 1986, a reduction of more than 32 million tons.

The industry desperately needs investment funds to modernize the capacity that remains. It is attempting to retain capacity at a reduced level of capability to ship finished steel but at a level sufficient to prevent increasing inordinate dependence on foreign sources of steel supply. Public policies will have a direct effect on how much steel capacity will remain in this country and how modern the remaining capacity will be.

It is within this framework that we have looked at the potential costs of H.R. 4567.

H.R. 4567 will impose additional costs on the steel industry in several ways. A major cost will be imposed by the requirement that utilities reduce sulfur oxide emissions. The Office of Technology Assessment, speaking of the costs of H.R. 4567, estimates that there will be a nationwide increase in utility costs of $3.4 billion to $4.3 billion per year. OTA estimates that the average electricity cost increase for residential consumers will be 2% to 3%. These electricity costs would vary significantly from state to state. For the five leading steel production states -- Indiana, Ohio, Pennsylvania, Illinois, Michigan (69% of 1984 steel production) -- OTA's estimates would indicate a weighted average 6.9% increase in electricity costs to residential consumers. Those increases to residential consumers, however, are proportionately much smaller than the effects of incremental costs to industrial consumers. Since proportionately more of the costs to residential consumers is in distribution rather than the generation costs which would be increased by H.R. 4567, correcting for this factor makes it clear that the steel industry's electricity rates would be increased by a minimum of 10%.

The steel industry is one of the largest purchasers of electric power in the nation. In 1984 the industry purchased over 49 billion kilowatts of power. A 10% increase in the cost of this power would add about $200 million to our annual production costs.

In addition to requiring sulfur oxide emissions reductions from the utility industry, H.R. 4567 would require reductions in sulfur oxide emissions from industrial processes. While specific limitations are not defined in the bill, it will require all reductions that are "economically and technically achievable." Sulfur oxide emissions from many steel operations are already controlled to some extent by existing State Implementation Plans, to the extent that they account for less than 1% of the nation's SO2 emissions. Many other sources, however, are not today controlled because the states have determined that these sources need not be controlled to achieve the National Ambient Air Quality Standards. In other words, those controls required by H.R. 4567 are not necessary for the protection of human health and welfare. AISI technical personnel have estimated that H.R. 4567 could impose on our industry additional capital costs of $300 million plus additional operating and maintenance costs of $100 million per year over and above the costs imposed by the existing Clean Air Act.

In the context of the staggering losses of the steel industry in recent years, an increase in annual operating costs of $300 million can only aggravate our serious situation. Considering that we have inadequate capital to maintain industry capacity at its present level, additional capital costs of $300 million will cause further serious deterioration in our financial condition.

Because of the high costs involved and the uncertain and conflicting scientific evidence regarding the cause of the acid rain problem, AISI strongly opposes passage of H.R. 4567.

Finally, and apart from the principal points mentioned above, there is an international competitiveness issue. If, contrary to our views, any legislation is passed which results in additional costs to the domestic industry, its enactment into law should be conditional on the development of a tax or tariff mechanism which would impose the same incremental costs on foreign steel entering this country. Otherwise, industries, such as steel, would incur a further competitive disadvantage when they are least able to bear it.

Mr. WAXMAN. Thank you very much, Mr. Peabody.

Mr. Marx.

STATEMENT OF WILLIAM MARX

Mr. MARX. Thank you, Mr. Chairman. I am William B. Marx, president of the Council of Industrial Boiler Owners, CIBO. CIBO is a broad-based association of industrial boiler operators and related equipment manufacturers with 50 members representing 19 major industrial sectors.

We are vigorously opposed to H.R. 4567. Nationwide emissions of SO_2 have dramatically declined over the last decade and are likely to continue to decline under existing law. Industrial SO_2 emissions have declined by 46 percent and electric utility emissions by 19 percent.

There are several causes for this downward trend in emissions from the industrial sector. Due in large part to dramatic energy conservation measures undertaken by industry in the last decade, total industrial energy conservation has actually declined by 7.5 percent from 1972 to 1984.

Very significantly with improved energy efficiency, many companies no longer need to expand their industrial steam generating base. Accordingly, approximately 80 percent of new industrial boiler installations serve to replace older, dirtier, less efficient units. The boiler replacement process by itself is resulting in significant SO_2 emission reductions.

In addition, industry is using its own waste products as fuels at a rapidly increasing rate. In the vast majority of cases these materials contain little or no sulfur and produce low NO_x emissions.

Furthermore, there are a large number of new low polluting solid fuel combustion systems currently being installed.

I would like briefly to address specific aspects of H.R. 4567 of particular concern to industrial boiler operators.

First, the bill would impose controls not only on large utility boilers but also on a wide range of much smaller industrial boilers.

Because industrial boilers are a fraction of the size of utility units, 30 times smaller on average, they do not enjoy utility economies of scale. Therefore, additional controls on industrial boilers would result in exorbitant costs to the public.

Furthermore, many industrial boilers would be required to pay twice for acid rain controls under H.R. 4567 through direct compliance costs and through increased electricity rates.

Industry is willing to pay its fair share of the electricity rate costs that result from pollution controls but industry should not be asked to pay again for acid rain controls by being required to retrofit their boilers at an exorbitant cost and little public benefit.

Second, CIBO has serous concerns with H.R. 4567's scheme of State control plans to achieve the emission rate targets for industrial boilers set forth in section 1982.

For example, if a State fails to develop a control plan acceptable to EPA within the short timeframes established in the bill, section 184(f)(2) provides that every industrial boiler in the State must individually meet the bill's emissions limitations. This requirement of unit-by-unit compliance unfairly penalizes industrial sources for failure of the State government to develop a control plan.

In addition, CIBO strongly supports the notion that sources should be given freedom of choice as to the means of achieving required emission reductions. However, while H.R. 4567 has been touted as affording freedom of choice, in fact, the bill gives States, not sources, the power to select the means to achieve reductions.

If anything, Congress should repeal the percentage reduction provision of section 111 of the Clean Air Act for industrial boilers. That provision severely limits the flexibility of owners of new fossil fuel fired steam generators to select the most cost-effective means of achieving emission reductions.

Finally, we have serous concerns with the provisions of section 185(a) which would apparently authorize the imposition of a fee up to one-half mil per kilowatt hour on the generation of electricity by industrial cogeneration plants.

Imposition of such a fee would discourage the development and operation of energy-efficient cogeneration projects and would impose significant economic costs on industrial cogenerators who, unlike utilities, cannot pass through such costs to the ratepayers.

I might mention that these cogeneration projects typically for every unit of useful output, there emissions are one-half what they would be from a utility source.

This concludes my oral statement. I would be pleased to answer any questions you may have.

[The prepared statement of Mr. Marx follows:]

COUNCIL OF INDUSTRIAL BOILER OWNERS

PRESIDENT
William B. Marx

SUBCOMMITTEE ON HEALTH AND THE ENVIRONMENT
COMMITTEE ON ENERGY AND COMMERCE
UNITED STATES HOUSE OF REPRESENTATIVES

STATEMENT OF
WILLIAM B. MARX, PRESIDENT
COUNCIL OF INDUSTRIAL BOILER OWNERS

May 1, 1986

I am William B. Marx, President of the Council of Industrial Boiler Owners (CIBO). I appreciate this opportunity to present CIBO's views on H.R. 4567.

CIBO is a broad-based association of industrial boiler operators and related equipment manufacturers, with 50 members representing 19 major industrial sectors. CIBO was formed in 1978 to promote the maximum exchange of information between industry and government relating to energy and environmental policies, laws, and regulations affecting industrial boilers. CIBO has a long-standing interest in the development of reasonable, cost-effective regulations of industrial boiler air emissions.

I. INTRODUCTION

In brief, CIBO is vigorously opposed to H.R. 4567. We believe that it would be a serious mistake to adopt sweeping, multibillion dollar "acid rain" legislation at this time. CIBO would emphasize the following points.

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(1) Nationwide emissions of SO_2 have dramatically declined over the last decade and are likely to continue to decline under existing law.

For example, according to the Joint Report of the Special Envoys on Acid Rain (January 1986) by Drew Lewis of the United States and William Davis of Canada:

> "The amount of SO_2 emitted in 1983 represents a 28 percent decline from the peak level -- 28.7 million tons -- emitted in 1973. Electric utility SO_2 emissions declined by 19 percent between 1973 and 1983, and industrial emissions declined by 46 percent." (Id. at 11, emphasis added.)

The steady decline in SO_2 emissions is further confirmed by EPA in its "National Air Pollutant Emission Estimates, 1940-1983" (December 1984), which shows that SO_2 emissions from industrial source fuel combustion declined from 4.1 teragrams in 1970 to 2.1 teragrams in 1983, a reduction of 49%.

The causes of this downward trend are several. First, due in large part to dramatic energy conservation measures undertaken by industry in the last decade, total industrial energy consumption has actually declined by 7.5% from 1972 to 1984, according to the Energy Information Administration. With this improved energy efficiency, many companies no longer need to expand their industrial steam generating base. Accordingly, approximately 80% of new industrial boiler installations serve to replace older, dirtier, less efficient units. The boiler replacement process, by itself, is resulting in significant SO_2 emission reductions.

In addition, industry is using lower sulfur fossil fuels and increasing its use of self-generated wastes as fuels. Data from the American Boiler Manufacturers Association, for example, shows that on an aggregate input basis, 44% of all industrial boilers sold in the period 1984-85 were designed to burn waste fuels or to utilize waste heat. In a preponderant majority of cases, these new units will burn fuels of very low sulfur content and produce low NOx emissions. Moreover, new low polluting solid fuel combustion technologies are being installed by industry at a rapid rate. Finally, various provisions of the Clean Air Act are working to limit SO_2 and NOx emissions. For example, New Source Performance Standards (NSPS) issued under Section 111 of the Act governing SO_2 and NOx emissions from new utility and industrial boilers greater than 250 MMBtu/hr heat input have been in place since 1971. These standards, which were revised for utility boilers in 1977, will continue to have a positive impact into the future.

(2) There remain enormous scientific uncertainties regarding the extent, causes, and effects of acid deposition. The wide gaps in the understanding of the acid rain "problem" make it impossible at present to make rational, informed decisions as to the need and extent of any further emission controls beyond those already required by existing laws and regulations. Notably, in a recent comprehensive study of the acid rain issue published by the

Hudson Institute, Dr. William M. Brown concluded that further scientific research is necessary before any acid rain legislation should be considered. This report concludes that "[n]early all of the claims about the impact of [acid precipitation] on various aspects of the environment appear to be either greatly exaggerated or simply wrong . . ." (The Great Acid Rain Mystery, January 1986, at ES-11.)

(3) Substantial scientific research into these questions is currently underway, and clearer answers are likely to emerge within the next few years. Extensive research into the many facets of the acid rain "problem" is being actively pursued. For example, the National Acid Precipitation Assessment Program (NAPAP), created by Congress in 1980, is engaged in an intensive, ten-year study of the environment impacts of acid deposition. Within a few years, we will be in a much better position to judge the wisdom of any massive acid rain control program.

(4) The three-year clean coal technologies program created by Congress last year may lead to the development of more cost-effective emission controls. It would be a mistake to prematurely require emission reductions before these technologies have an opportunity to be developed and tested.

II. SPECIFIC COMMENTS ON H.R. 4567

While CIBO firmly believes that it is premature to consider any new legislation to control acid rain, CIBO submits for the record the following specific comments on H.R. 4567.

First, H.R. 4567 would impose controls, not only on large utility boilers, but also on a wide range of much smaller industrial boilers. Thus, many existing industrial boilers would have to be retrofitted at exorbitant cost. *This approach is neither cost-effective nor equitable*. Since utility boilers are on average *30 times* as large as industrial boilers, utilities enjoy favorable economies of scale in reducing air emissions as compared with industrial boilers. Thus, the cost of removing a ton of SO_2 from a utility boiler is *3 to 4 times* lower than the cost of the same unit reduction from an industrial boiler. It costs approximately $400 to remove a ton of SO_2 for utility boilers, as compared to $1400 or more for industrial boilers. In view of these cost-effectiveness differences, it would be a costly error to impose stringent new controls on industrial boilers.

Furthermore, many industrial boilers owners would be required to pay *twice* for acid rain controls under H.R. 4567, through direct compliance costs *and* through increased electricity rates. Industry is willing to pay its *fair* share of the electricity rate costs that result from pollution controls, but industry should not be asked to pay *again* for acid rain controls by being required to retrofit their boilers at exorbitant cost and little public benefit. In addition, CIBO is concerned that H.R. 4567's emphasis on protecting *residential* ratepayers from rate shock may encourage state utility commissions to shift a disproportionate share of any electricity rate increases to *industrial* customers.

Second, CIBO has serious concerns with H.R. 4567's scheme of state control plans to achieve the emission rate targets for industrial boilers set forth in Section 182. CIBO's concerns may be summarized as follows:

(1) Since decisions as to which sources will have to install controls or switch to alternate fuels will be made by individual states, it is exceedingly difficult to estimate the impact of this legislation on the fuel and equipment costs for industry. Although CIBO cannot precisely quantify this impact, in view of the high cost of scrubbers and the anticipated sharp rises in the prices of low sulfur fuels (due in large measure to increased utility use of such fuels), the costs to industry are certain to be quite substantial.

(2) The scheme of individual state control plans creates the potential for undue discrimination among different industrial sectors within a state. For example, to reach the average emission rate of 1.2 lb/MMBtu for SO_2 for industrial boilers, a state may decide to target industry A to achieve substantial reductions, while leaving industry B relatively unharmed. The danger of political favoritism is all the more serious in view of the absence of any assurance of public participation either in the develop-

ment of plans at the state level, or in the review of such plans by EPA.

(3) If a state fails to develop a control plan acceptable to EPA within the short time frames established in the bill, Section 184(f)(2) provides that every industrial boiler in the state must individually meet the bill's emission limitations (i.e., 1.2 lb/MMBtu for SO_2 and 0.6 lb/MMBtu for NOx). This requirement of unit-by-unit compliance unfairly penalizes industrial sources for failure of the state government to develop a control plan. Achievement of bill's emission targets for individual industrial boilers would be prohibitively expensive for many units, particularly smaller units, and would be technically impossible for some boilers. For example, some pulverized coal boilers have not been demonstrated to be able to achieve 0.6 lb/MMBtu for NOx. Moreover, the threat of this penalty being triggered places undue power in the hands of EPA in negotiations with states over proposed control plans.

(4) CIBO strongly supports the notion that sources should be given "freedom of choice" as to the means of achieving required emission reductions. However, while H.R. 4567 has been touted as affording "freedom of choice," in fact, the bill gives states, not sources, the power to select the means to achieve

reductions. If anything, Congress should repeal the percentage reduction provision of Section 111 of the Clean Air Act for industrial boilers. That provision severely limits the flexibility of owners of new fossil fuel fired steam generators to select the most cost-effective means of achieving emission reductions.

Third, CIBO has serious concerns with the provisions of H.R. 4567 establishing a fee on electrical generation to fund an interest subsidy program to protect, under Section 187, "residential customers from excessive rate increases due to the installation of pollution controls." In particular, Section 185(a) would apparently authorize the imposition of a fee of up to 1/2 mill/kwh on the generation of electricity by industrial cogeneration plants. Imposition of such a fee would discourage the development and operation of energy-efficient cogeneration projects and would impose significant economic costs on industrial cogenerators who, unlike utilities, cannot pass through such costs to ratepayers. Furthermore, as noted earlier, Section 187's emphasis on using the fees collected to protect "residential" customers may from rate increases may invite discriminatory treatment of industrial customers by individual state utility commissions. Finally, the Section 187 limitation on the use of any funds to subsidize debt service on pollution control equipment (scrubbers) is inequitable and creates a bias in favor of states mandating utilities to use costly scrubbers as opposed to requiring utilization of low sulfur fuels.

Fourth, CIBO vigorously opposes the inclusion of controls on "industrial process emissions" of SO_2 and NOx established under Section 183. Such controls are to be imposed by states to achieve specific emission reduction targets identified by EPA. These targets are to be developed through an EPA study identifying "the total Statewide potential reductions in emissions of sulfur dioxide and oxides of nitrogen which are economically and technically achievable . . . by stationary sources of industrial process emissions in each State." (Section 183(b).) There is no provision in the bill for any opportunity for public participation in most of the significant actions to be taken by EPA to implement this program. To be sure, Section 188(2) requires EPA to establish "by rule" categories of industrial process emissions. However, this is the only part of the process where public comment is allowed. In both the conducting of this study, and in the development of the "statements" EPA is to transmit to each state identifying the total reductions available, public participation is not required. EPA's individual statements to the states, which essentially become binding emission limitations for industrial processes in each state, are thus insulated from the public notice and comment process. This is tantamount to private rulemaking, and is contrary to basic notions of due process and administrative law.

Fifth, the bill's amendments to Section 111 of the Clean Air Act inappropriately require EPA to promulgate New Source Performance Standards (NSPS) governing NOx emissions from fossil fuel fired industrial boilers greater than 50 MMBtu/hr heat input and to revise the existing utility boiler NSPS for NOx to establish specific limitations for subbituminous coal (0.3 lb/MMBtu) and bituminous coal (0.4 lb/MMBtu). These provisions improperly interfere with the Administrator's expert discretion in determining appropriate categories and classes of sources for NSPS, and in establishing standards for these categories and classes.

This concludes CIBO's prepared statement. I would be pleased to answer any questions you may have.

Mr. WAXMAN. Thank you very much, Mr. Marx.
Dr. Jackson.

STATEMENT OF WALTER E. JACKSON

Mr. JACKSON. Thank you, Mr. Chairman. I am Walter Jackson, director of environmental affairs for United States Steel Corp.

United States Steel Corp. is opposed to the enactment of H.R. 4567. It would significantly affect our company through increases in electric utility rates, additional controls on our stationary sources and cause a further deterioration of our international competitiveness.

At a time when our industry is making every effort to cut costs and modernize our facilities, the cost burdens of H.R. 4567 are of special concern in that they may ultimately prove to have been unnecessary to impact the acid rain deposition issue.

United States Steel does not suggest inaction on the acid deposition issue. Instead, we believe that knowledge of the causes, extent, and effects of acid deposition must be further investigated prior to embarking upon a major commitment such as H.R. 4567.

United States Steel is competing in a world market where every incremental unit of cost may determine whether our production facilities will remain competitive. The bill significantly adds to our incremental unit costs at many of our facilities. For example, at our Gary, IN, plant, the corporation's largest steel production facility, there would be increased purchased electricity cost that could be over $1 million per month.

The steel plant would also have incurred increased raw material costs. For example, taconite iron ore from Minnesota, limestone and dolomite from Michigan, and coal from Kentucky and West Virginia would all bear increased incremental costs resulting from direct utility rate increases. All of these price increases will detract from the Gary plant's competitiveness with subsidized foreign steel imports.

United States Steel generates electricity and burns fuels in facilities that are 20- to 30-year-old facilities. This fuel burning operation is economical because of the available low cost coke oven and blast furnace gasses which are produced as byproducts from coke and ironmaking operations.

Given the age of these facilities, capital costs for NO_x and SO_x controls would be a questionable investment. Shutdown of these facilities would require the purchase of higher priced electricity.

In instances where NO_x and SO_x controls are installed, such expenditures would divert capital dollars away from the modernization of steel production facilities. In either event, the incremental costs for steel products would adversely impact our competitiveness.

It should be noted that modernization of steel production facilities provides positive environmental benefits. For example, installation of a continuous caster both saves energy and significantly reduce environmental impacts.

We believe that continued research will facilitate the development of innovative and cost effective control strategies and the development of process modernization and we therefore oppose the enactment of H.R. 4567.

Thank you.

[The prepared statement of Mr. Jackson follows:]

STATEMENT BY

DR. WALTER E. JACKSON

DIRECTOR-ENVIRONMENTAL AFFAIRS

UNITED STATES STEEL CORPORATION

BEFORE THE

SUBCOMMITTEE ON HEALTH AND THE ENVIRONMENT

COMMITTEE ON ENERGY AND COMMERCE

U.S. HOUSE OF REPRESENTATIVES

HEARING ON ACID DEPOSITION

MAY 1, 1986

Mr. Chairman and Members of the House Subcommittee on Health and the Environment. I am Dr. Walter E. Jackson, Director-Environmental Affairs for United States Steel Corporation.

H.R. 4567, the Acid Deposition Control Act of 1986, has drawn renewed attention to the acid rain issue. United States Steel Corporation is opposed to enactment of H.R. 4567. It would significantly affect the steel industry through increases in electric utility rates, additional controls on our stationary sources and cause a further deterioration of our international competitiveness. At a time when our industry is making every effort to cut costs and modernize our facilities, the cost burdens of H.R. 4567 are of special concern and may ultimately prove to have been unnecessary.

U. S. Steel does not suggest inaction on the acid deposition issue. Instead, we believe that knowledge of the causes, extent and effects of acid deposition must be further investigated prior to embarking upon a major environmental commitment such as H.R. 4567.

U. S. Steel is competing in a world market where every incremental unit of cost may determine whether its production facilities will remain competitive to justify continued operation. This bill significantly adds to our incremental unit costs at many of our facilities. For example, at the Gary, Indiana plant, the Corporation's largest steel production facility, H.R. 4567, as reported by Temple, Barker and Sloane, Inc., would increase our purchased electricity cost by 21 percent -- well over $1 million per month. The steel plant would also incur increased raw material costs. For example, taconite iron ore from Minnesota, limestone and dolomite from Michigan, and coal from Kentucky and West Virginia would all bear increased incremental costs resulting from direct utility rate increases. All of these price increases will detract from the Gary plant's competitiveness with subsidized foreign steel imports.

The Temple, Barker and Sloane, Inc. report may not reflect the actual cost impacts that industry may incur from the utilities compliance with H.R. 4567. In a few urban areas, utilities have been forced by state public utility commissions to establish utility rate structures that result in industrial subsidies to residential ratepayers. This shortsightedness has been recognized as contributing to business relocations to Sun Belt states. The bill's surcharge reflects another business subsidy to residential ratepayers. These subsidies have two major disadvantages. First, subsidized ratepayers are discouraged from energy conservation. This adds to pressure on utilities to build more generation capacity and/or maintain older facilities. Second, the cost to U.S. business is reflected in increased product costs -- products which in most instances have to compete with imports. This can lead to increased consumption of import products, to the loss of U.S. produced goods and the loss of U.S. jobs.

U. S. Steel generates approximately 22 percent of its total electricity requirements. The actual percentage of self-generated electricity varies between steel plants. This electricity is generated in 20- to 30-year-old steam electric plants. These facilities provide low cost electricity because of the availability of low cost coke oven and blast furnace gasses which are produced as byproducts from coke and ironmaking operations. We also operate other industrial boiler facilities to provide process and heating steam. Given the life of these facilities, it is likely that capital costs for NOX and SOX controls would not be a justified investment. The shutdown of many of these steam electric plants would require the purchase of higher-priced electricity. In instances where NOX and SOX controls were installed, such expenditures would divert capital dollars for modernization of steel production facilities. In either event, the incremental costs for steel products would adversely impact steel's competitiveness.

It should be noted that modernization of steel production facilities provides positive environmental benefits. We have calculated that a new continuous casting process which increases yield and thereby reduces requirements for coke, iron, and steel could improve potential controlled environmental emissions. Reduced emissions would include 880 lbs/day of particulates, 1070 lbs/day of sulfur oxides, 220 lbs/day of total suspended solids, 10 lbs/day of oil, 20 lbs/day of NH3-N, 4 lbs/day of organics and 1 lb/day of metals. The new process could also reduce potential solid waste disposal of 571,000 lbs/day, most of which is blast furnace slag. The above does not include the potential reduction of coal used to generate the electricity formerly needed in processing steel, which would translate into emission reduction of 250 lbs/day of particulates, 24,000 lbs/day of solid waste, and 2,060 lbs/day of sulfur oxides.

It is our belief that modernization should be encouraged as an innovative approach to cost effective environmental programs. H.R. 4567 excludes modernization and other innovations that can work within the economy to provide economic growth with enhanced environmental protection. We believe that continued research will facilitate innovative and cost effective control strategies for acid deposition. Therefore, we urge the Subcommittee to support additional research but not report H.R. 4567 to the full Committee.

Thank you.

Mr. **Waxman**. Thank you very much, Dr. Jackson. Mr. Haymaker.

STATEMENT OF GEORGE T. HAYMAKER, JR.

Mr. **Haymaker**. Thank you, Mr. Chairman. My name is George Haymaker. I am executive vice president of Alumax, Inc. I appear today on behalf of the Aluminum Association in opposition to H.R. 4567.

As written, the bill would place an unfair burden on the U.S. primary aluminum industry. Our industry does business in a highly competitive world market made more difficult because we pay about the highest electricity rates in the world.

The concerns of the aluminum industry are centered on the three provisions of H.R. 4567 which require emissions reductions for electrical utilities, require reductions in industrial process emissions and impose a half mil per kilowatt hour tax.

Most importantly, all three requirements would combine to directly affect over 40 percent of the current primary aluminum capacity in the United States placing an unfair burden on a substantial segment of our industry.

Eleven primary aluminum plants in nine States would be serious jeopardized by the requirements of H.R. 4567. Other facilities will be affected less but significantly.

The bill requires our industry to bear an unfair share of the costs of the proposed legislation. Electricity represents about one-third of the cost of producing aluminum. Escalating electricity costs in the United States compared to the rest of the world have damaged the ability of the U.S. aluminum industry to compete in the world market.

The cost for electricity for aluminum companies in the United States served by fossil fuel utilities are above 28 mils per kilowatt hour while the average cost for electricity supplied to their free world competition is 12 mils.

Electricity rates in the United States are basically uncompetitive and H.R. 4567 will clearly widen our disadvantage.

Because U.S. electricity rates are not competitive for our industry, we have seen some plant closures and reductions in capacity. However, companies in our industry have worked closely with their power suppliers, notably with the Bonneville Power Administration as well as utilities in Missouri and South Carolina to provide relief in the form of moderated electricity rates.

Further discussions are in progress with others. While these modifications still do not provide rates comparable to those in other aluminum producing countries, we believe that with them and our modern technology a major part of our industry can and will survive for the long term.

This legislation threatens to erase these modest gains and destroy the fragile balance we have achieved.

The association has surveyed its member companies regarding the impact of the legislation. Our preliminary findings indicate the cost of electricity at 11 locations would rise by as much as 11 mils per kilowatt hour translating to an increase in the cost of making aluminum of up to 12 percent.

Two of these plants are my company's plants in East Alco, in Frederick, MD, and in South Carolina.

Further, the legislation could require additional process emissions controls on virtually every primary aluminum reduction facility in the United States regardless of the source of its electric power. This will cost between $10 and $50 million in capital costs per plant and between $1½ and $2½ million in operations and maintenance costs per year per plant.

A third but not insignificant area of concern to the industry is the tax on electricity which would add $1½ to $2½ million in annual costs at affected plants.

Aluminum is a commodity traded on the world market. Producers sell their product on the basis of world market conditions. It is not possible to pass on the additional costs incurred as a result of H.R. 4567. We regard it as unfair to impose such a heavy financial burden on our industry jeopardizing its viability and the thousands of jobs it provides aluminum workers.

The cumulative effect of these requirements also contradicts a stated purpose of H.R. 4567, to keep residential rate increase under 10 percent. Loss of aluminum companies as customers will require residential and commercial customers to provide the lost revenue for the affected utilities.

Rate increases to these customer classes could be in excess of 20 percent. Aluminum reduction facilities are important customers of the utilities which serve them. For small utility companies, this means about 20 percent or more of their capacity and 17 percent or more of their revenue.

On major systems, aluminum companies represent between 2 and 5 percent of the system's capacity and revenues.

While it is clear that this legislation would have very negative economic effects, it is not clear that it would help solve the problem at which it is directed. Previous testimony by both government and private witnesses has demonstrated that the scope of the acid rain problem and the proposed solution to deal with it are subject to significant question.

In any event, if such solutions are imposed the cost should be born broadly by all who benefit.

The U.S. aluminum industry with our world standard technology can continue to compete on a worldwide basis provided governmental policies do not burden the industry further.

As proposed, H.R. 4567 places an extremely unfair financial burden on a major segment of the primary aluminum industry.

[The prepared statement of Mr. Haymaker follows:]

Testimony of George T. Haymaker, Jr. on behalf of the Aluminum Association, Inc. on H.R. 4567.

My name is George T. Haymaker, Jr, Executive Vice President, Alumax, Inc., San Mateo, California. I appear today on behalf of the member companies of the Aluminum Association, Inc. in opposition to H.R. 4567.

The Aluminum Association is the primary source for statistics and information about aluminum and the aluminum industry. Its membership represents virtually all of the domestic producers of primary ingot and Association members account for 85 percent of the shipments of semifabricated aluminum products in the country.

As written, H.R. 4567 places a severe strain on the U.S. primary aluminum industry. This industry operates in a highly competitive world market, made more difficult because it pays among the highest rates for electricity in the world.

The concerns of the aluminum industry are centered on the provisions of Title I, and the controls which would be imposed on electric utility boilers, as well as for aluminum plant industrial process emissions, and the proposed half mil per kilowatt hour tax. All of which will increase our cost by 15 percent.

We regard it as unfair to impose such a heavy financial burden on our industry as to jeopardize its viability and the thousands of jobs it provides aluminum workers.

The Aluminum Process

Primary aluminum is produced by the electrolytic reduction of alumina (aluminum oxide). The reduction (the separation of aluminum from oxygen) takes place in a cell containing a bath of molten salts, cryolite and aluminum fluoride. Cells are from 10 to 15 feet wide, 20 to 40 feet long and 3 to 4 feet deep. They are lined with carbon and connected in an electrical series of 100 to 240 cells to form a potline. The carbon lining is in contact with the molten aluminum metal and serves as the cathode. A pot room is as much as 1/2 mile in length under one roof with a series of dry scrubbers or bag houses along the roof line to collect fluoride.

The process uses direct current and operates 24 hours a day, 365 days a year. From 800 to 3,000 pounds of aluminum are produced per day per pot. Depending on the particular technology, it takes between 6.2 and 7.8 kilowatt hours of electricity to make one pound of aluminum.

State of the Market

Aluminum is a commodity traded on the world market and producers of aluminum sell their product on the basis of international market conditions.

When the aluminum industry testified in 1984 on acid rain legislation, there were 32 primary aluminum reduction facilities operating in the U.S. At the beginning of this year, seven of those plants had been closed and a number of others operating at reduced capacity because they are not competitive.

The industry's present condition is aggravated by:

- U.S. electricity rates and rate-making policy.
- Trade policies and practices of foreign governments.
- Non-commercial operating practices of foreign companies, many of which are government owned or influenced.

The Importance of Electricity

Electricity represents about one-third of the cost of producing aluminum. Its escalating cost in the U.S. compared to the rest of the world has damaged the ability of the U.S. aluminum industry to compete in the world market. Power costs for those aluminum plants served by fossil fueled utilities are approximately 28 mils per kilowatt hour while the average of the free world, exclusive of the United States, is 12 mils. Even though some countries enjoy a natural comparative advantage, others subsidize electricity rates, or the natural resources used to generate electricity, for their aluminum industries. The result: electricity rates in the U.S. are basically non-competitive.

The Impact of H.R. 4567

This situation would be exacerbated severely by the requirements of H.R. 4567. Several power suppliers, most notably Bonneville Power Administration as well as utilities in Missouri and South Carolina have, after difficult negotiations, provided relief to aluminum producers in the form of somewhat moderated electricity rates. These modifications still do not provide rates comparable to those available in most other aluminum producing countries. These modest gains would be erased by the implementation of the provisions of H.R. 4567, which enunciates a policy of requiring industry to bear an unfair share of the cost of this legislation.

A survey of member companies conducted since the introduction of the legislation has provided us with some initial information as to impact. As a result of the requirements which the bill would

place on electric utilities, the cost of power to primary aluminum facilities at eleven locations in the United States would jeopardize their economic viability. Our preliminary findings indicate the cost of electricity would rise by three to eleven mils per kilowatt hour, which translates to an increase in the cost of making aluminum from three percent to twelve percent. It is questionable as whether these increases could be passed on.

The impact of the legislation is made even more severe when the cost of the process emissions controls which would have to be added to virtually every reduction facility in the U.S., regardless of the source of its electric power is taken into account. This would involve between $10 and $35 million in capital costs per plant and between $1 1/2 and $2 1/2 million in operations and maintenance costs per year per plant.

A third area of concern to the industry is the .5 mils per kilowatt hour tax on all electricity generated by other than hydro or nuclear power. The effect of this tax would be an additional $1 1/2 to $2 1/2 million annually per affected plant.

There is another indirect but significant impact. Loss of alumnium companies as customers will require residential and commercial customers to provide the full revenue support for the affected utilities. Rate increases to these customer classes could be in excess of 20 percent. Aluminum reduction facilities are important customers of the utilities which serve them. For small utility companies, we are talking about 20 percent or more of capacity and 17 percent or more of revenue. On major systems, they represent between 2 and 5 percent of the system's capacity and revenues.

The Cost Not Supported by Benefits

While it is clear that this legislation would have very bad economic effects, it is not clear that it would help solve the problem at which it is directed. Based on testimony by both government and private witnesses, it is clear that the scope of the acid rain problem and the proposed solution to deal with it are subject to significant questions.

H.R. 4567 treats the acid rain problem as though it were one involving human health. The problem as described in the general literature is an environmental welfare issue.

The costs associated with the bill are enormous for our industry and far outweigh the questionable benefits to be achieved. There is still much to be learned in order to address the issue effectively and appropriately.

Conclusion

The primary aluminum industry is extremely competitive on a world wide basis. This fact dictates that U.S. policies should seek to avoid jeopardizing a vital segment of our industrial base. As proposed H.R. 4567 places an extremely unfair financial burden on a major segment of the primary aluminum industry which may well render it uneconomic.

I appreciate the opportunity to appear before you and would be happy to answer any questions.

AFFECTED ALUMINUM REDUCTION FACILITIES

Indiana
Warrick

Kentucky
Hawesville
Sebree

Maryland
Frederick

Missouri
New Madrid

Ohio
Hannibal

South Carolina
Mt. Holly

Tennessee
Alcoa
New Johnsonville

Texas
Rockdale

West Virginia
Ravenswood

Mr. SIKORSKI [presiding]. Thank you, Mr. Haymaker.

Mr. HAYMAKER. Thank you for the opportunity, sir.

Mr. SIKORSKI. Mr. Profozich.

STATEMENT OF RUSSELL PROFOZICH

Mr. PROFOZICH. Thank you, Mr. Chairman. My name is Russell Profozich. I am senior utility economist with Elcon, the Electricity Consumers Resource Council.

Elcon is an association of large industrial consumers of electricity. Our members have facilities in most of the 50 States and consume about 5 percent of all the electricity sold in the United States. Virtually all of our members would be affected by acid rain legislation.

Our members are concerned about the environment and they are also concerned about acid rain. We have studied very carefully the acid rain issue and developed the following position.

We believe that a verifiable link between emission reductions and improvements in the environment has not yet been established.

In addition, any acid rain legislation will be very expensive. Cost estimates for H.R. 4567 range from $3.4 billion per year to $9.2 billion per year. Rate increases to industrials have been estimated to be as much as 40 percent.

In addition, there has been no cost-benefit analysis performed to ensure that the benefits of the proposal are equal to its cost or that significant environmental improvements will result.

Emissions of SO_2 currently are below historic levels and they are expected to decline further in the future without any new control programs.

The United States faces a price disadvantage for electricity with Canada and with other industrialized nations. U.S. industry already subsidizes other ratepayers by more than $2.5 billion per year. Acid rain legislation would worsen the U.S. price disadvantage for electricity and would likely increase the industrial subsidy of other ratepayers.

The U.S. industry faces severe competition in world markets. We must be assured that any mandated emissions reductions program will produce benefits at least equal to its cost.

The forest industry, which perhaps has more at stake than any other industry in the United States, has seen no evidence of forest decline due to air pollution. It has also stated that an ineffective program, that is one that produces uncertain results, may be worse than no program at all.

On the basis of our analysis of the acid rain issue, Elcon recommends: That additional mandated emission control programs are not warranted at this time; that increased funding for clean coal technologies and demonstration projects that are intended to reduce the cost of emissions reductions should be considered; and that research into all aspects of the acid rain issue to define cost-benefit relationship of proposed programs should be performed.

Thank you very much.

[Testimony resumes on p. 266.]

[The prepared statement of Mr. Profozich follows:]

ELCON

STATEMENT OF THE
ELECTRICITY CONSUMERS RESOURCE COUNCIL (ELCON)
TO THE
UNITED STATES HOUSE OF REPRESENTATIVES
SUBCOMMITTEE ON HEALTH AND THE ENVIRONMENT
OF THE COMMITTEE ON ENERGY AND COMMERCE
ON
H.R. 4567
THE ACID DEPOSITION CONTROL ACT OF 1986

The Electricity Consumers Resource Council (ELCON) is pleased to submit this statement to the Subcommittee on Health and the Environment of the United States House of Representatives. The purpose of this statement is to present ELCON's views on H.R. 4567, The Acid Deposition Control Act of 1986.

ELCON is an association of large industrial consumers of electricity with facilities in most of the 50 states and in many foreign countries.[1] Our members produce a wide range of products including steel, aluminum, motor vehicles, chemicals, glass, industrial gases, food products and textiles.

ELCON members consume approximately ten percent of all electricity sold to industrial customers and nearly five percent all

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[1] This statement is presented in behalf of the following ELCON members: Air Products and Chemicals, Inc.; Anheuser-Busch Companies, Inc.; Armco Inc.; Bethlehem Steel Corporation; Cone Mills Corporation; Corning Glass Works; Diamond Shamrock Chemicals Company; Dow Chemical U.S.A, E.I. du Pont de Nemours and Company; General Motors Corporation, Hershey Foods Corporation; Hercules Incorporated; Kaiser Aluminum and Chemical Corporation; Olin Corporation; PPG Industries, Inc.; A.E. Staley Manufacturing Company, Stauffer Chemical Company; and Union Carbide Corporation.

electricity consumed in the United States. Our members require an adequate and reliable supply of electricity at reasonable prices based on the costs incurred in providing service. Due to the impact of any acid rain legislation on the cost and reliability of electric service, ELCON has a significant interest in the proposed legislation.

I. Summary and Recommendations

ELCON has analyzed carefully the acid rain issue. Our findings include:

- o A verifiable link between emission reductions and improvement in environmental quality has not been established;
- o Any acid rain legislation will be expensive. Estimates range from $2.4 billion to $ 9.2 billion annually. Rate increases to industrials could be as much as 40.4 percent;
- o No cost-benefit analysis of the proposed legislation has been performed;
- o The U.S. faces a relative price disadvantage for electricity with Canada and other industrialized nations;
- o U.S. industry already subsidizes other domestic ratepayers by more that $2.5 billion annually; Acid rain legislation would worsen the electricity price disadvantage of U.S. industry and is likely to increase industry's subsidy of other customers;

- U.S. industry faces severe competition from other nations. We simply cannot afford to pay for an expensive acid rain program which may not provide commensurate benefits.

ELCON recommends that:

- Additional mandated emission control programs in the U.S. are not warranted at this time;
- Increased funding for clean coal technologies and demonstration projects should be considered;
- Research into all aspects of the acid rain phenomenon should be continued to define cost-benefit relationships of proposed control programs.

II. The Industrial Viewpoint

A. No linkage established

The analysis of the acid rain phenomenon continues. Scientists have gained knowledge and are closer in defining the links between SO_2 and NO_x emissions and acidity in precipitation. However, any linkage between acidity in precipitation and damage to the environment or between reduction in emissions and improvement in the environment remain largely unknown.

Legislating emissions reductions at this time puts the cart before the horse. Many studies are underway--funded by the federal government, the electric utility industry and others-- that are attempting to define this linkage. These studies are crucial. They should be completed and their findings analyzed before legislation mandating a major emissions reduction program is proposed.

B. Emissions Have Declined and are Expected to Decline Further Without Legislation

Emission of SO_2 have declined significantly in recent years and are expected to continue to decline in the future without additional controls. In 1983, SO_2 emissions in the U.S. were 28 percent below their peak level of 1973. Electric utility SO_2 emissions declined 19 percent during this period despite a 60 percent increase in utility coal consumption. Industrial SO_2 emissions also decreased by 46 percent.[2] NO_x emissions during this period remained relatively stable with emissions from mobile sources declining by 9 percent in spite of a 5 percent increase in vehicle miles driven.

The National Coal Association (NCA) reports that SO_2 emissions from the nation's electric utilities have continued to decline through 1985 and are projected to remain on the decline through at least 1990.[3]

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[2] Drew Lewis/William Davis, "Joint Report of the Special Envoys on Acid Rain." January, 1986

[3] National Coal Association, "The Downward Trend in Sulfur Dioxide Emissions at Coal-Fired Electric Utilities," Washington, D.C., 1986.

The NCA surveyed virtually every coal-fired electric utility generating plant above 50 megawatts in the United States. On the basis of actual coal consumption and hours of operation it determined that SO_2 emissions have declined at existing plants as well as at new plants. The reasons for this decline are due to four factors:

- o New Source Performance Standards (NSPS) for new plants
- o Regional shift in electricity demand
- o Change in the sulfur content of coal
- o Increased scrubber activities

The NCA expects these trends to continue into the future and projects a 16.9 percent decrease in electric utility SO_2 emissions between 1984 and 1990. This reduction would be achieved without additional emissions control programs.

C. An Emissions Reduction Program Would Be Costly

Estimates of the cost of an emissions reduction program vary significantly. However, all show that the costs are very large. Factors affecting the cost estimates include: allocation of reduction requirements among states and utilities within a state; control technology used in each instance; cost of that technology as applied to the individual facility; degree of fuel switching; cost of low-sulfur coal; etc.

The Office of Technology Assessment (OTA) estimates that implementation of H.R.4567 would cost between $3.4 billion and $4.3 billion per year.[4] It estimates that electric utility rate increases on a statewide average basis would increase as much as 14 percent due to this program. Cost estimates for NO_x removal are not provided. An analysis of H.R. 4567 prepared for the Edison Electric Institute (EEI) by Temple, Barker and Sloan, Inc., predicts that H.R. 4567 as applied to electric utilities would cost $9.2 billion per year in 1986 dollars.[5] This study also predicts that electric rates at individual utility companies would increase as much as 44.9 percent on a system-wide basis. Rate increases for individual customer classes are estimated to be as high as 29.9 percent for residential customers, 29.4 percent for commercial customers and 40.4 percent for industrial customers (see Table 1).

A recent study of SO_2 and NO_x emissions reductions performed by ICF, Incorporated for the National Wildlife Federation predicted that an 8 million ton SO_2 reduction

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[4] Office of Technology Assessment, "Analysis of a 1986 Acid Rain Control Proposal." Staff Paper prepared by the OTA Oceans and Environment Program, Washington, D.C. April 9, 1986.

[5] Edison Electric Institute, "Economic Evaluation of H.R. 4567," prepared by Temple, Barker & Sloane, Inc., Washington D.C., April 14, 1986.

Table 1

ELECTRIC UTILITY CUSTOMER RATE INCREASES UNDER HR 4567
BY CUSTOMER CLASS, FOR UTILITIES WITH OVER 1,000 MW COAL-FIRED CAPACITY

Average Increase Over First Five Years of Full Compliance

STATE	COMPANY	COMPLIANCE COST (MILLION $)	RATE INCREASE (3) RESIDENTIAL	RATE INCREASE (3) COMMERCIAL	RATE INCREASE (3) INDUSTRIAL	RATE INCREASE (3) WHOLESALE	RATE INCREASE (3) TOTAL
AL	Alabama Power Co.	199	6.5	6.0	9.9	12.1	8.5
AR	Arkansas Power & Light Co.	51	3.1	3.9	5.6	5.9	4.8
AZ	Arizona Public Service Company	8	0.7	0.8	1.0	1.3	0.8
CA	Southern California Edison	6	0.2	0.2	0.2	0.3	0.2
CO	Colorado Ute Electric Association	5					3.6
CO	Public Service Company of Colorado	9	1.0	1.2	1.7	1.7	1.2
DC	Potomac Electric Power Co.	60	3.5	3.2	4.3	3.9	3.6
DE	Delmarva Power & Light Co.	20	2.0	2.4	3.6	3.3	2.6
FL	Florida Power Corp.	70	4.9	5.0	7.3	6.5	5.6
FL	Gulf Power Co.	72	13.2	13.6	17.6	17.0	14.6
FL	Tampa Electric Company	107	10.8	11.2	18.3		13.6
GA	Georgia Power Co.	485	9.9	8.6	13.0	13.9	10.8
IA	Iowa Public Service Co.	30	17.1	13.3	16.7	19.6	15.6
IA	Iowa Southern Utilities Co.	26	15.8	13.0	20.2	22.9	17.0
IL	Central Illinois Light Co.	15	3.4	3.5	5.6	6.1	4.2
IL	Central Illinois Public Service	147	16.7	21.4		26.5	20.6
IL	Commonwealth Edison Co.	156	6.1	7.3	9.6	9.5	7.6
IL	Electric Energy, Inc.	49			29.4	25.9	28.9
IL	Illinois Power Co.	165	16.4	17.4	28.9	19.0	22.1
IN	Indiana & Michigan Electric Co.	74	6.4	6.9	8.8	10.6	9.0
IN	Indianapolis Power & Light Co.	190	18.1	19.3	26.0		21.4
IN	Indiana-Kentucky Electric	85					26.2
IN	Northern Indiana Public Service Co.	336	17.2	16.0	27.3	25.6	25.0
IN	Public Service Company of Indiana	295	13.9	15.9	25.0	22.4	17.8
KS	Kansas Power & Light Co.	91	1.3	1.8	2.1	3.6	1.9
KY	Big Rivers Electric Corp	33					37.4
KY	Kentucky Power Co.	95	29.9	27.1	39.1	47.1	36.5
KY	Kentucky Utilities Co.	115	25.7	26.6	33.2	36.0	29.5
KY	Louisville Gas and Electric Co.	50	9.1	9.6	13.6	20.9	10.3
LA	Cajun Electric Power Coop	79					8.3
MA	New England Power Company	91		10.1	9.0	18.7	19.7
MI	Consumers Power Co.	129	6.0	6.1	8.5	8.5	7.2
MI	Detroit Edison Co.	295	7.1	6.1	9.4	10.9	7.9
MN	Minnesota Power & Light Company	39	5.1	4.9	6.1	9.9	6.5
MN	Northern States Power Co.	81	6.2	6.6	9.2	23.2	8.2

Temple, Barker & Sloane, Inc. for the Edison Electric Institute. April 21, 1986.

Notes: 1. Based on compliance costs from "Economic Evaluation of H.R. 4567, The Acid Rain Deposition Control Act of 1986," Temple, Barker & Sloane for the Edison Electric Institute; April 14, 1986.
2. Excludes any payments to or proceeds from the cost-sharing fund in the bill.
3. Based on 1984 customer rates, escalated to future years at an assumed 5 percent rate of inflation.
4. Individual utility costs include adjustments for major interchanges of power where that would affect rate impacts.
5. All costs shown in 1986 dollars.

Table 1 (continued)

ELECTRIC UTILITY CUSTOMER RATE INCREASES UNDER HR 4567 BY CUSTOMER CLASS, FOR UTILITIES WITH OVER 1,000 MW COAL-FIRED CAPACITY (continued)

Average Increase Over First Five Years of Full Compliance

STATE	COMPANY	COMPLIANCE COST (MILLION $)	PERCENT INCREASE (3) RESIDENTIAL	PERCENT INCREASE (3) COMMERCIAL	PERCENT INCREASE (3) INDUSTRIAL	PERCENT INCREASE (3) WHOLESALE	PERCENT INCREASE (3) TOTAL
MO	Associated Electric Cooperative	129					44.9
MO	Kansas City Power & Light Co.	93	11.0	13.1	18.9	19.6	13.7
MO	Union Electric Co.	377	17.1	19.0	26.1	28.7	20.3
MS	Mississippi Power Co.	50	11.3	12.3	17.3	19.0	13.9
NC	Carolina Power & Light Co.	137	5.7	6.1	8.0	8.4	7.0
NC	Duke Power Company	196	5.1	5.7	7.6	7.0	6.3
NJ	Public Service Electric & Gas Co.	78	3.4	4.0	4.9	6.0	4.0
NM	Public Service Co. of New Mexico	4	1.0	1.3	1.3	1.6	1.2
NY	Niagara Mohawk Power Corp.	78	3.9	3.9	5.2	4.3	3.6
OH	Cincinnati Gas & Electric Co.	111	10.1	10.1	13.9	15.3	10.7
OH	Cleveland Electric Illuminating Co.	136	9.3	10.2	16.3	3.0	11.3
OH	Columbus & Southern Ohio Electric	93	12.3	14.1	17.9	19.9	16.7
OH	Dayton Power and Light Company	93	10.4	11.9	18.9	18.3	12.3
OH	Ohio Edison Co.	204	10.0	11.0	17.1	21.3	13.8
OH	Ohio Power Co.	197	11.9	13.1	23.0	37.3	20.0
OK	Oklahoma Gas & Electric Co.	8	0.6	0.6	0.8	1.1	0.7
OR	Pacific Power & Light Co.	61	6.3	6.9	8.1	11.3	7.0
PA	Duquesne Light Company	26	2.0	3.1	3.2	4.6	2.6
PA	Pennsylvania Electric Co.	226	37.5	39.0	40.1	41.3	33.1
PA	Pennsylvania Power Co.	53	14.0	19.2	29.0	42.9	23.9
PA	Pennsylvania Power & Light Co.	196	7.0	7.3	9.7	8.3	7.8
PA	West Penn Power Co.	79	9.2	9.7	12.1	19.0	10.0
SC	South Carolina Electric & Gas Co.	79	7.3	9.1	13.2	13.2	9.9
TN	Tennessee Valley Authority	601					13.9
TX	Houston Lighting & Power Co.	10	0.2	0.3	0.4	0.4	0.3
TX	Southwestern Electric Power Co.	6	0.7	0.8	1.0	1.2	0.9
TX	Southwestern Public Service Co.	8	10.6	10.6	19.3	15.1	11.3
TX	Texas Utilities Electric Company	10	0.3	0.4	0.5	0.3	0.4
UT	Utah Power & Light Co.	10	0.8	0.8	1.4	1.0	1.1
VA	Virginia Electric and Power Co.	105	3.9	4.3	5.9	6.2	4.5
WI	Wisconsin Electric Power Co.	141	10.0	11.9	16.5	19.7	12.9
WI	Wisconsin Power & Light Co.	113	20.6	21.9	32.3	43.2	20.3
WV	Appalachian Power Co.	219	14.3	15.0	29.3	25.6	19.4
WV	Monongahela Power Co.	138	21.4	23.1	36.0	31.9	29.2

Temple, Barker & Sloane, Inc. for the Edison Electric Institute. April 21, 1986.

Notes:
1. Based on compliance costs from "Economic Evaluation of H.R. 4567, The Acid Rain Deposition Control Act of 1986," Temple, Barker & Sloane for the Edison Electric Institute; April 14, 1986.
2. Excludes any payments to or proceeds from the cost-sharing fund in the bill.
3. Based on 1984 customer rates, escalated to future years at an assumed 5 percent rate of inflation.
4. Individual utility costs include adjustments for major interchanges of power where that would affect rate impacts.
5. All costs shown in 1986 dollars.

(with "cost-effective" NO_x reductions) would cost $2.4 billion per year (in 1985 dollars, and a 12 million ton SO_2 reduction (with "cost-effective" NO_2 reductions) would cost $4.8 billion per year in 1985 dollars.[6] Table 2 summarizes these cost estimates.

ELCON cannot verify the accuracy of these studies. The important point is that all of these cost estimates are quite large. The Congress should consider carefully the impact of these costs before it acts to institute any acid rain program.

D. Cost-Benefit Analysis Required

Good business decisions require a cost-benefit analysis. None of ELCON's members would institute a $9 billion per year program without some assurance that the benefits derived would equal the costs.

Likewise, acid rain legislation should produce benefits in exchange for its cost. ELCON has seen no attempt to quantify the benefits expected from the proposed legislation. We have seen no evidence that links reductions in emissions with improved environmental quality. Our members are concerned about the environment. We simply seek assurance that a

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[6] National Wildlife Federation, "Analysis of Sulfur Dioxide and Nitrogen Oxide Emission Reduction Alternatives With Electric Rate Subsidies," prepared by ICF, Incorporated, Washington D.C. October, 1985.

Table 2

Summary of Cost Estimates of Proposed Acid Rain Legislation

Source	Cost Estimates
OTA Analysis of H.R. 4567	$3.4 billion to $4.3 billion/year (1986 $)
EEI Analysis of H.R. 4567	$9.2 billion/year first five years (1986 $)
ICF Analysis:	
8 million ton SO_2 reduction*	$2.4 billion/year
12 million ton SO_2 reduction*	$4.8 billion/year (1985 $)

*(with "cost effective" NO_x controls)

multi-billion dollar program will provide commensurate benefits.

III. The U.S. - Canadian Controversy: Is Acid Rain an Environmental or Economic Issue?

A. The U.S. Price Disadvantage

U.S. industry faces a price disadvantage for electricity in relation to many other industrialized countries. Table 3 and the accompanying chart show that U.S. industrial electricity rates are among the highest of industrialized countries. The chart also shows that industrial electricity rates in the U.S. have remained at a high level over the years, while industrial rates in other countries have declined.

An expensive emissions reduction program would tend to worsen this price disadvantage. As the figures in the EEI study of H.R. 4567 indicate industrial electricity consumers can expect to pay a disproportionate share of the cost of any emissions reduction program.

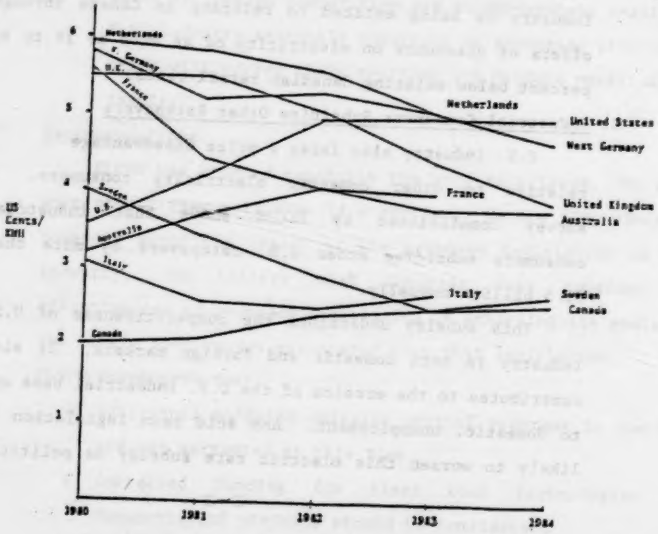
B. Canada's cost advantage

As the figures in Table 3 show, Canada enjoys a substantial cost advantage in electricity relative to the United States. Canada also exports a large amount of electricity to the United States. In 1985, Canadian electricity exports to the U.S. totaled 41.5 million megawatt-hours representing about $1.4 billion dollars.

Table 3

AVERAGE ANNUAL INDUSTRIAL ELECTRICITY PRICES FOR MAJOR INDUSTRIALIZED COUNTRIES 1980-1984 (U.S. CENTS/KWH)*

Country	1980	1981	1982	1983	1984
United States	3.6	4.2	4.9	5.0	5.0
Canada	2.0	2.1	2.4	2.5	2.6
France	5.6	4.4	4.1	4.0	N/A
West Germany	5.8	5.2	5.3	5.1	4.7
Italy	3.1	2.6	2.5	2.7	N/A
United Kingdom	5.5	5.5	5.1	4.4	3.9
Sweden	4.0	3.4	2.9	2.5	2.7
Netherlands	5.9	5.8	5.6	5.1	N/A
Australia	3.2	3.7	4.1	3.8	3.8



*Source: U.S. Department of Energy Energy Information Administration, International Energy Prices, 1980-1984; Washington, D.C., August 1985.

This electricity is sold in the U.S. based upon the avoided cost of U.S. production. For example, Ontario Hydro prices its electricity exports at 80 percent of the cost of U.S. production. Electricity rates in Canada however, are based on cost-of-service. This creates a two-tier pricing system with rates lower for domestic consumption and higher for export. At the same time U.S. industry is being enticed to relocate in Canada through offers of discounts on electricity of as much as 59 to 66 percent below existing Canadian retail rates.

C. Industrial Consumers Subsidize Other Ratepayers

U.S. industry also faces a price disadvantage relative to other domestic electricity consumers. A survey commissioned by ELCON shows that industrial consumers subsidize other U.S. ratepayers by more than $2.5 billion annually.[7]

This subsidy undermines the competitiveness of U.S. industry in both domestic and foreign markets. It also contributes to the erosion of the U.S. industrial base and to domestic, unemployment. Any acid rain legislation is likely to worsen this electric rate subsidy as political pressure is applied to minimize the impact of acid rain controls on residential customers.

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[7] Electricity Consumers Resource Council (ELCON), Profiles In Electricity Issues: Cost-of-Service Survey, Washington D.C., March, 1986. A copy of the Profile is attached to this statement.

An acid deposition control program would also exacerbate the relative price disadvantage of U.S. utilities. This would, in turn worsen the competitive position of U.S. industry in world markets.

At a time when industrial plant closings and lost sales to foreign competition are an unfortunate reality, U.S. industry seriously questions an expensive proposal which will worsen their position and produce uncertain results.

IV Recommendations

ELCON has studied carefully the acid rain issue. We agree with others that acid rain is a problem. We are also concerned however, about the impact of the proposed legislation on U.S. industry. We believe that Congress must consider the effectiveness of proposed legislation in achieving its goals and the likely cost burden associated with that legislation. ELCON recommends that:

- o additional mandated emission control programs in the U.S. are not warranted at this time;
- o increased funding for clean coal technologies and demonstration projects should be considered;
- o research into all aspects of the acid rain phenomenon should be continued to define cost-benefit relationships of proposed control programs.

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1707 H Street, N.W., Suite 1080
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NUMBER 1 MARCH 1986

PROFILES IN ELECTRICITY ISSUES:

Cost-of-Service Survey

This survey shows that industrial electricity consumers pay more than $2.5 billion annually in subsidies to other ratepayers.

This subsidy is very substantial. $2.5 billion is roughly equal to the negative balance of trade with England or Italy. It is enough to pay the annual electric bills of more than 4 million homes or nearly twice the number of residential customers in New York City.

Artificially high U.S. industrial rates negatively impact the ability of U.S. industry to compete in both foreign and domestic markets, particularly when industrial rates in other countries are subsidized. They also encourage U.S. industry to relocate electricity-intensive operations offshore and explore other options such as self-generation and cogeneration.

This survey compares the after-tax rate of return on investment for industrial and residential customers with the system average rate of return. All customer classes should be equally profitable to the utility when costs are allocated properly. However, this survey shows that:

- **The rate of return provided by industrials exceeds that of residentials in 79 of the 84 cost-of-service studies (or in 94% of the studies).**
- **Nine times out of ten the industrial rate of return exceeds both the residential and the system average rate of return (in 76 of the 84 studies).**

PROFILES IN ELECTRICITY ISSUES are published in the interest of better understanding of the economic and social impact of proposals related to electricity. ELCON seeks an efficient and adequate supply of electric energy at prices based on costs, not only for the benefit of industrial consumers and their labor force, but also for all consumers of industrial products and thus the national economy. For a copy of other PROFILES, write or call ELCON at the address above.

BACKGROUND

Cost-of-service studies determine the total costs incurred by a utility in providing service to its customers and the allocation of those costs to customer classes. Revenue collected from each customer class then may be compared with that class' cost responsibility to determine the extent to which each class is reimbursing the utility for the costs it incurred in providing service.

Many of the costs incurred by a utility are "joint" costs, incurred on behalf of all customers rather than for a specific customer class. As a result, the allocation of a utility's costs requires engineering, economic and accounting expertise, as well as a significant amount of informed judgment. Several appropriate cost-of-service methodologies have been developed for this process.

The particular method selected depends upon such factors as the diversity of the system load, the types and sizes of customers and customer classes and the type, time and rate of usage. A proper cost-of-service method will allocate each category of costs to the responsible customer class. Appropriately designed electric rates then will recover these costs (including a fair return on investment) from each class. A proper cost-of-service based rate design will produce approximately equal rates of return on investment from each of the utility's customer classes. That is, the cost burden will be equitably shared among all of the utility's customers.

There are three general categories of cost-of-service study methodologies: demand methods, consumption methods and load curve methods. These methods differ mainly in their allocation of fixed costs among the various customer classes.

Fixed costs generally are demand-related. A utility builds generating units and transmission lines based upon the maximum requirement expected to be imposed on its system at any point in time. Thus, the fixed costs of this equipment are incurred to meet the peak load(s) of the system. A proper cost-of-service methodology allocates these costs to each customer class in proportion to that class' contribution to the system peak(s) (or maximum demands).

Other costs are "customer-related" costs -- mainly meter reading and billing costs. These are related to the number of customers on the system. Still other costs are "energy related" -- mainly fuel costs -- which are related to electricity (KWH) consumption.

Some equipment is used only to serve particular customer classes. For example, the distribution network provides service to residential and small commercial customers at low voltage levels. The costs of this equipment should be borne only by those who use it.

The revenue burden is being equitably shared when each customer class produces roughly the same rate of return to the utility. On the other hand, there is a strong indication that the customers of a class are being overcharged (or undercharged) if a cost-of-service study shows that a particular customer class is producing a rate of return significantly above (or below) the utility's average system rate of return.

PREVIOUS RESEARCH

ELCON commissioned surveys of cost-of-service studies in 1977, 1978, and 1982. The results of these surveys indicate that industrial electricity users pay more than their fair share of utilities' costs of service.

These surveys show that in the vast majority of instances, the industrial rate of return exceeds both the residential and the total system rate of return. Specifically, this earlier research demonstrated that the industrial rate of return exceeded the residential rate of return in 588[1] -- or 84 percent of the 701 studies included in the 1982 survey. The industrial rate of return exceeded the system average rate of return in 526 of the studies. Alternatively, the residential rate of return was less than the system average rate of return in 610 -- or 87 percent -- of the studies.

CURRENT RESEARCH

The current survey encompasses 84 cost-of-service studies for 73 electric utilities operating in 32 states (several utilities operate in more than one state). The studies include actual and forecasted test periods for 1979 through 1986 and reflect a variety of cost allocation methodologies. The results of the survey are provided in Appendix Table A-1 at the end of this Profile. This table is essentially the same as those contained in previous ELCON cost-of-service profiles.

Three independent utility rate consultants provided cost-of-service information for this survey: Drazen-Brubaker & Associates, Inc., St. Louis, Missouri; Kennedy and Associates, Inc., Atlanta, Georgia; and Cook, Eisdorfer, Willer & Associates, Inc., St. Louis, Missouri.

Data are from electric utility cost-of-service studies on file with each of the consultants. In each case, the cost-of-service study provided is the most recent available for the utility included in the survey. Thus, unlike earlier ELCON surveys, only one cost-of-service study is provided for each utility.

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[1] Cost of Service Survey, Profiles in Electricity Issues, No. 6, Electricity Consumers Resource Council, Washington, D.C., May 1982.

The data compare after-tax rates of return for residential and industrial service with the system average rate of return. Various cost-of-service methodologies are represented in the data provided.

For each utility, that methodology determined by the particular consultant to be most appropriate is included, considering the electric load, usage and other customer characteristics of that utility. The consultant calculates the rate of return (in percent) for the industrial and residential customer classes and the system average rate of return for each utility.

In 1984 (the latest year for which sales figures are availble), the utilities included in the survey had total kilowatt-hour (KWH) sales of 1,320 billion KWH, or approximately 57.9 percent of total energy sales for the U.S. electric utility industry. Total industrial sales for these utilities was 448.9 billion KWH or about 53.6 percent of total U.S. industrial electricity sales in 1984.

Survey results show that the industrial rate of return exceeds the residential rate of return in 79 -- or 94 percent -- of the 84 cost-of-service studies contained in the survey. In 76 cost-of-service studies -- or 90 percent of the total -- the industrial rate of return exceeds both the residential and the system average rates of return.

This survey clearly shows that industrial customers usually are required to pay more for electricity, relative to the cost of producing service, than do residential customers.

Contrary to popular misconception, industrials generally are required to subsidize other electricity consumers; industrial users are not being subsidized by residential customers.

MAGNITUDE OF THE SUBSIDY

How significant is the subsidy that industrial electricity users pay to other electricity customers? This survey determines the dollar subsidy paid by industrial consumers in each cost-of-service study by determining the revenue that must be deducted from the industrial class' revenue requirement to equilibrate the rate of return on investment from that class with the system average rate of return. This information is contained in Table 1.

For the 73 utilities included in the survey, Table 1 shows that the industrial subsidy totals $1.37 billion in 1984 dollars. For industrial users, this represents approximately 3.1 mills (or more than 3 tenths of a cent) for each KWH of electricity purchased in 1984. Based on total industrial sales for the U.S. electric utility

TABLE 1

INDUSTRIAL SUBSIDY TO OTHER RATE PAYERS

STATE	KWH (000) RESIDENTIAL	KWH (000) INDUSTRIAL	KWH (000) SYSTEM	TOTAL SUBSIDY 1984 $ (000)	INDUSTRIAL SUBSIDY (cents/kwh)
ALABAMA	9,174,780	14,651,012	32,000,704	$65,442	0.45
ARKANSAS	5,682,151	6,803,579	18,741,268	$17,881	0.26
CALIFORNIA	37,850,821	35,882,149	116,653,298	$248,268	0.69
CONNECTICUT	6,232,209	7,168,737	15,365,884	$46,262	0.65
DELAWARE	1,460,922	2,104,925	5,127,948	$3,722	0.18
FLORIDA	41,674,215	11,416,160	85,621,265	$27,851	0.24
GEORGIA	12,004,092	19,970,447	43,458,560	$55,900	0.28
ILLINOIS	27,218,115	22,290,253	93,472,067	$138,844	0.62
INDIANA	16,090,650	20,990,692	52,751,276	$34,238	0.16
KANSAS	4,134,241	4,297,350	12,604,433	$10,750	0.25
KENTUCKY	2,513,602	2,234,226	7,900,847	$13,258	0.59
LOUISIANA	12,551,836	21,854,533	43,687,789	$60,757	0.28
MAINE	2,358,416	1,892,432	5,896,465	$4,545	0.24
MARYLAND	6,564,194	6,248,537	18,290,683	$2,951	0.05
MASSACHUSETTS	1,124,206	1,030,982	3,265,866	$2,085	0.20
MICHIGAN	21,192,753	30,743,001	68,110,463	$142,219	0.46
MINNESOTA	5,917,702	16,969,311	25,392,683	$54,702	0.32
MISSOURI	10,836,757	8,164,226	29,778,512	$23,121	0.28
NEW JERSEY	13,349,873	10,259,035	46,599,606	$37,105	0.36
NEW MEXICO	1,517,939	1,054,474	4,719,063	$9,926	0.94
NEW YORK	13,750,831	16,603,651	46,315,469	$28,277	0.17
NORTH CAROLINA	19,026,862	20,501,980	55,795,684	$48,572	0.24
OHIO	26,756,003	33,651,166	82,854,890	$39,272	0.12
OKLAHOMA	5,927,792	8,319,885	16,627,887	$18,952	0.23
PENNSYLVANIA	27,802,962	30,170,276	88,541,407	$89,747	0.30
SOUTH CAROLINA	9,488,599	15,929,841	32,458,812	$29,079	0.18
TEXAS	47,544,960	36,644,078	163,072,149	$38,968	0.11
UTAH	2,716,432	3,853,949	9,375,216	$12,474	0.32
VIRGINIA	19,314,868	16,079,866	43,189,440	$44,209	0.27
WEST VIRGINIA	6,161,538	7,782,854	19,570,354	$11,383	0.15
WISCONSIN	8,304,584	9,843,686	27,317,694	$8,779	0.09
WYOMING	760,779	3,557,828	5,710,591	$3,790	0.11
TOTAL	427,005,684	448,965,121	1,320,268,273	$1,373,329	0.31
ELECTRIC ENERGY SALES-1984	777,421,000	837,661,000	2,279,923,000		
RATIO UTILITY/ TOTAL SALES	0.549	0.536	0.579		

industry in 1984 -- 837.7 billion KWH -- this amounts to a total industrial subsidy of $2.6 billion. Alternatively, industrial KWH sales for the utilities included in this survey account for 53.6 percent of total industrial KWH sales for 1984. If extrapolated to represent 100 percent of 1984 sales, the industrial subsidy to other customer classes would total approximately $2.56 billion.

SUMMARY AND CONCLUSIONS

This survey of cost-of-service studies updates earlier studies commissioned by ELCON and quantifies the extent to which industrials subsidize other electricity users.

Survey results show that in 79 -- or 94 percent -- of the 84 cost-of-service studies, the industrial class rate of return on investment exceeds that of the residential class. In 76 cost-of-service studies, the industrial rate of return also exceeds the system average rate of return. Industrials, thus, generally are required to subsidize other electric utility customers.

This profile also quantifies the subsidy paid by industrials to other electricity users. For each of the 84 cost-of-service studies, electric rate consultants estimated the change in revenue requirement necessary to cause the industrial rate of return to equal the system average rate of return. In 1984 dollars, this annual subsidy amounts to $1.37 billion or more than 3 mills (3 tenths of a cent) for each KWH of industrial sales represented by those utilities included in the survey.

When extrapolated to represent 100 percent of 1984 industrial KWH sales, this subsidy totals approximately $2.5 billion. This subsidy is very substantial. It suggests that industrial rates are approximately 6 percent higher on average than they should be. $2.5 billion is roughly equal to the negative balance of trade with England or Italy. It is enough to pay the annual electric bills of more than 4 million homes -- nearly twice the number of residential customers in New York City.

Despite these facts, proposals continue to be advanced which would further undermine established cost-of-service ratemaking principles. These proposals threaten to produce additional distortions in electricity rates and to increase the burden borne by industrial users in subsidizing other classes of electricity users.

These proposals also undermine the competitiveness of U.S. firms in both domestic and foreign markets. Industrials cannot simply pass on increased electricity costs to their customers. This is particularly true when industrial electricity rates in other countries are subsidized or when, as is sometimes the case, industry is offered special long-term electricity discounts in exchange for building new facilities in foreign countries. This process leads to erosion of the U.S. industrial base, contributes to domestic unemployment and causes U.S. industry to reduce electricity purchases through such means as self-generation and cogeneration.

APPENDIX TABLE A-1

SUMMARY OF COST-OF-SERVICE STUDIES

STATE	UTILITY	YEAR OF STUDY	COST-OF-SERVICE METHOD	RATE OF RETURN--% RESIDENTIAL	INDUSTRIAL	SYSTEM
ALABAMA	ALABAMA PWR CO.	1981	FOUR CP	4.95	8.60	7.12
ARKANSAS	ARKANSAS PWR & LT	1984	SINGLE CP	8.71	10.92	9.64
	OKLAHOMA G & E	1983	A&E	7.77	6.63	7.31
	SOUTHWESTERN ELEC PWR	1983	SINGLE CP	6.52	9.56	7.61
CALIFORNIA	PACIFIC G & E	1984	TWELVE CP	0.24	12.04	5.34
	SAN DIEGO G & E	1986	TWELVE CP	5.29	23.86	11.57
	S. CALIFORNIA EDISON	1983	TWELVE CP	-0.06	4.34	2.23
CONNECTICUT	CONNECTICUT PWR & LT	1984	A&E	6.73	13.88	10.19
DELAWARE	DELMARVA PWR & LT	1983	FIVE CP	9.88	12.18	11.70
FLORIDA	FLORIDA PWR CORP	1984	WINTER/SUMMER CP	6.01	9.06	7.12
	FLORIDA PWR & LT	1984	WINTER/SUMMER CP	6.52	10.24	8.55
	GULF PWR CO	1984	THREE CP	6.53	9.25	7.70
	TAMPA ELEC CO	1984	WINTER/SUMMER CP	5.25	7.14	6.16
GEORGIA	GEORGIA PWR CO	1984	NEAR PEAK	3.16	10.91	8.40
ILLINOIS	CENTRAL ILLINOIS LT	1982	SINGLE CP	4.14	13.36	8.38
	CENTRAL ILL PUB SERV	1981	THREE CP	4.00	8.82	6.57
	COMMONWEALTH EDISON	1982	SINGLE CP	7.59	15.03	11.27
	ILLINOIS PWR CO	1983	SINGLE CP	4.43	16.58	9.18
	UNION ELEC CO	1983	THREE CP	-0.78	8.59	6.81
INDIANA	IND & MICH ELEC CO	1984	TWELVE CP	7.94	6.69	7.86
	INDIANAPOLIS PWR & LT	1981	TWELVE CP	6.98	9.57	8.38
	NORTH INDIANA PUB SERV	1982	TWO CP	2.80	6.24	4.45
	PUB SERV CO OF INDIANA	1984	TWELVE CP	10.69	11.44	11.25
	SOUTH INDIANA G & E	1979	FOUR CP	4.31	7.28	5.88
KANSAS	KANSAS G & E	1982	FOUR CP	7.21	15.16	9.69
	KANSAS PWR & LT	1980	THREE CP	4.50	6.12	5.73
KENTUCKY	LOUISVILLE G & E	1982	SINGLE CP	4.34	11.11	7.65
LOUISIANA	GULF STATES UTIL	1982	4 CP/ A&E	7.24	10.72	9.23
	LOUISIANA PWR & LT	1984	FOUR CP	2.33	6.95	4.51
	NEW ORLEANS PUB SERV	1983	FOUR CP	-4.99	13.87	3.69
MAINE	CENTRAL MAINE PWR CO	1979	NEAR PEAK	8.36	12.36	11.00
MARYLAND	BALTIMORE G & E	1983	SINGLE CP	7.53	9.59	9.37
MASSACHUSETTS	WESTERN MASS ELEC	1983	A&E	10.02	11.31	9.71
MICHIGAN	CONSUMERS PWR CO	1985	TWELVE CP	7.70	10.92	9.82
	DETROIT EDISON	1985	SINGLE CP	1.87	5.50	3.97
	IND & MICH ELEC CO	1985	TWELVE CP	5.79	6.50	6.76
MINNESOTA	MINNESOTA PWR & LT	1981	A&E	1.31	7.67	5.50
	NORTHERN STATES PWR	1981	SINGLE CP	6.14	9.08	7.89
MISSOURI	ARKANSAS PWR & LT	1984	SINGLE CP	9.78	11.77	10.58
	EMPIRE DISTRICT ELEC	1981	SINGLE CP	6.04	23.22	10.25
	KANSAS CITY PWR & LT	1984	NEAR PEAK	1.69	5.81	4.71
	UNION ELEC CO	1984	TWO CP	2.00	4.66	3.44

APPENDIX TABLE A-1

SUMMARY OF COST-OF-SERVICE STUDIES

STATE	UTILITY	YEAR OF STUDY	COST-OF-SERVICE METHOD	RATE OF RETURN--% RESIDENTIAL	INDUSTRIAL	SYSTEM
NEW JERSEY	JERSEY CENTRAL PWR & LT	1984	FOUR CP	7.99	14.14	10.06
	PUB SERV ELEC & GAS	1981	SINGLE CP	8.45	12.03	10.77
NEW MEXICO	PUB SERV CO OF N MEXICO	1984	TWELVE CP	6.27	15.29	10.65
	TEXAS-N MEXICO PWR CO	1982	THREE CP	7.89	14.59	9.48
NEW YORK	CENTRAL HUDSON G & E	1982	WINTER/SUMMER CP	6.90	14.89	10.98
	CONSOLIDATED EDISON	1981	SINGLE CP	11.43	12.05	11.56
	N Y STATE E & G CORP	1986	NEAR PEAK	9.24	10.07	10.06
	ORANGE & ROCKLAND	1983	SINGLE CP	9.28	12.16	11.01
NORTH CAROLINA	CAROLINA PWR & LT	1983	SINGLE CP	7.86	11.70	9.70
	DUKE PWR CO	1984	SINGLE CP	5.31	8.51	7.10
OHIO	CINCINNATI G & E	1984	TWO CP	6.16	14.36	10.55
	CLEVELAND ELEC ILLUM	1983	FOUR CP	14.05	15.13	14.55
	COLUMBUS & S OHIO ELEC	1983	SINGLE CP	7.49	9.97	9.83
	OHIO EDISON CO	1985	TWELVE CP	9.51	10.04	11.08
	OHIO PWR CO	1983	TWELVE CP	8.97	11.07	10.30
	TOLEDO EDISON CO	1983	TWELVE CP	9.36	8.52	9.29
OKLAHOMA	OKLAHOMA G & E	1984	SINGLE CP	5.59	9.69	7.87
PENNSYLVANIA	DUQUESNE LT CO	1984	SINGLE CP	12.22	13.79	11.19
	PENN ELEC CO	1985	TWO CP	6.29	9.12	7.80
	PENN PWR & LT	1985	TWO CP	7.33	10.97	8.92
	PHILADELPHIA ELEC	1984	FOUR CP	5.87	11.67	9.70
	WEST PENN PWR CO	1984	SINGLE CP	8.02	8.72	8.87
SOUTH CAROLINA	CAROLINA PWR & LT	1983	SINGLE CP	7.19	12.45	10.09
	DUKE PWR CO	1984	SINGLE CP	4.41	9.33	6.88
	S CAROLINA E & G	1983	SINGLE CP	8.70	8.14	8.71
TEXAS	CENTRAL PWR & LT CO	1981	FOUR CP	5.57	11.20	8.59
	EL PASO ELEC CO	1983	FOUR CP	8.64	10.30	9.58
	GULF STATES UTIL	1983	FOUR CP	7.31	8.35	8.03
	HOUSTON LTG & PWR	1984	NEAR PEAK	9.51	11.55	10.46
	SOUTHWESTERN ELEC PWR	1983	FOUR CP	8.47	11.00	10.22
	TEXAS-N MEXICO PWR CO	1983	FOUR CP	8.18	25.82	10.16
	TEXAS UTILITIES ELEC	1983	A&E	12.50	13.52	12.46
UTAH	UTAH PWR & LT	1982	FIVE CP	9.55	13.56	11.93
VIRGINIA	APPALACHIAN PWR CO	1982	TWELVE CP	8.65	9.77	9.41
	VIRGINIA PWR CO	1984	A&E	9.02	12.78	10.76
WEST VIRGINIA	APPALACHAIN PWR CO	1983	TWELVE CP	5.85	8.48	7.41
	MONONGAHELA PWR CO	1984	SINGLE CP	8.13	11.58	10.11
WISCONSIN	WISCONSIN ELEC PWR CO	1986	TWELVE CP	9.23	11.30	10.53
	WISCONSIN PWR & LT CO	1986	TWELVE CP	9.37	6.56	8.55
	WISCONSIN PUB SERV CORP	1986	TWELVE CP	5.76	13.97	9.69
WYOMING	PACIFIC PWR & LT	1983	SINGLE CP	7.45	10.20	9.43
	UTAH PWR & LT	1983	EIGHT CP	5.33	9.47	8.49

NOTES TO TABLES

1. Information included in tables 1 and A-1 was provided from cost-of-service studies on file with utility rate consultants.

2. Cost-of-service methods presented are those recommended by the rate consultants as most appropriate for the particular utility and test year being considered. These include:

   Four CP -- four coincident peaks
   Single CP -- maximum annual coincident peak
   A&E -- average and excess
   Twelve CP -- twelve coincident peaks
   Five CP -- five coincident peaks
   Winter/Summer CP -- winter and summer seasonal coincident peaks
   Near Peak -- system peak demands within a certain % of the annual system peak (e.g., 90% of peak) are used to allocate costs.
   Three CP -- three coincident peaks
   Two CP -- two coincident peaks
   4 CP/ A&E -- combination of four coincident peaks and average and excess methods
   Eight CP -- eight coincident peaks

3. Killowatt-hour sales for each state are those provided by the cost-of-service studies for those utilities included in the survey.

4. Electric Energy Sales--1984 are total KWH sales for the U.S. electric utility industry for 1984 as determined by the Edison Electric Institute.

5. Industrial Subsidy is that amount of revenue necessary to be deducted from the industrial class revenue requirement to cause the rate of return for that class -- as determined by the cost-of-service study for the test year under consideration -- to equal the system average rate of return. Figures are in 1984 dollars.

6. Industrial Subsidy per KWH is derived by dividing the industrial subsidy in 1984 dollars by each state's industrial KWH sales for those utilities included in the survey.

Mr. Sikorski. Thank you. We will recess for 15 minutes until 5 minutes after 12 for the vote and then we will start up with questions at 5 minutes after 12.

[Brief recess.]

Mr. Waxman. The meeting will come back to order. Dr. Masciantonio, on the final page of your testimony you urge us to consider that time is our ally, that current industry projections indicate many of the existing stationary sources proposed for regulation are scheduled for replacement by new clean facilities.

You go on to say that we shouldn't spend billions on existing sources. Do you see anywhere in this bill where we prohibit industry from building a new facility as the method for compliance and isn't it true that it is the industry itself that has the strong incentive to keep existing facilities operating. Some utilities are operating old plants without controls decades beyond their predicted shutdown dates, isn't that correct?

Mr. Masciantonio. I think our statement is saying, Congressman, that as an alternative to imposing these requirements for retrofitting controls and fuel switchings and what—not that we feel that a substantial reduction can occur in the absence of that kind of legislation just through the normal processes of attrition and building of new facilities.

Mr. Waxman. For your understanding of what this bill does and does not require, it doesn't require retrofit controls. It requires emission reductions.

Mr. Masciantonio. I understand that but we would presume that there are only so many ways of doing that and one of those would be to retrofit controls which I think would be a big imposition on the industry.

Mr. Waxman. That was only one way of doing it. There are other ways of doing it as well.

Mr. Masciantonio. Yes, sir.

Mr. Waxman. Another may be fuel switching. A third may be closing down some of those old plants. Isn't there an incentive to keep those old plants open as long as possible because of the new source performance requirements for new plants?

Mr. Masciantonio. I think in a given situation, that has certainly got to be considered depending on what the economic consequences are of new versus old. It is a factor.

Mr. Waxman. Mr. Profozich, you have cited the NCA for authority that we will see a 16-percent decline in emissions between now and 1990 without any control program. EPA doesn't agree with that assessment for a variety of reasons and I have some additional doubts about the way those data are gathered.

But if NCA is right, isn't it true that the cost of complying with this bill will be even less than any of the projections because States will be able to take credit for these reductions and do you see anything in this bill that prohibits this?

Mr. Profozich. No, sir. I don't see anything that prohibits it. To the extent that emissions would go down anyway, I agree that the costs would be less. We don't necessarily vouch for any of the estimates. Our position is that all of them are very high and that all of them would substantially increase electricity rates to our members with what we believe is without any necessarily significant improvement in acidity in the environment.

Mr. **Waxman**. There is a benefit study at EPA which we have in the record as a result of our first hearing on this bill which showed a tremendous benefit by the reductions that would be accomplished.

Mr. Sipple, you state that the subsidy program is tied to residential rate relief only. You go on to state that industrial ratepayers are already subsidizing consumers by $2.75 billion annually. Isn't it true that industrial and commercial ratepayers pay less on a kwh basis for electricity than residential ratepayers?

Mr. **Sipple**. Yes, it is true that they pay less on a kwh basis but the cost to provide that service is less as well. Large industrial users, with their high load factor consumption patterns don't require distribution and transformation costs that are normally associated with a residential service.

Mr. **Waxman**. But they are getting cheaper electricity, aren't they?

Mr. **Sipple**. The price is lower on a kilowatt-hour basis, that is correct, sir. But that is not necessarily cheaper electricity based on the cost of the service.

Mr. **Waxman**. It is cheaper than what is paid by the residential electricity user, isn't that correct?

Mr. **Sipple**. There would be a lower price per kwh, that is correct.

Mr. **Waxman**. All right. Dr. Jackson, on Tuesday, the Secretary of Energy suggested that the effect of this bill would be to increase switching from coal to foreign oil rather than low sulfur coal. United States Steel owns Marathon Oil which has much of its oil reserves in Libya. Tell us, do you consider this a reliable and secure supply of oil for U.S. utilities at this time?

Mr. **Jackson**. Is the question a supply of oil for U.S. utilities, a reliable supply of oil for U.S. utilities?

Mr. **Waxman**. That is correct.

Mr. **Jackson**. I don't know that I would be qualified to answer that question so far as world supply of oil available for utilities.

Mr. **Waxman**. I suppose the question is more intended to highlight and underscore the fact that when the Secretary of Energy tells us they are going to switch to foreign oil imports, all you have to do is look at Libya right now to try to understand whether that would be a secure source of fuel in a tumultuous world and whether the business decision would automatically flow in that direction as opposed to low sulfur coal.

Thank you very much. Mr. Madigan.

Mr. **Madigan**. Mr. Haymaker, you indicated that there was an analysis that shows that the electricity rate increases could raise the cost of producing aluminum by as much as 12 percent.

Can you quantify what that would mean in terms of the U.S. industry's ability to compete internationally?

Mr. **Haymaker**. I am not sure how to quantify it, Representative Madigan. We have seen a substantial number of plants close in the past several years as a result of the rapid rise in U.S. electricity rate. This came about for a variety of reasons and is well documented in an excellent study by Department of Commerce published in 1985.

Those which have not closed are struggling competitively but we think with our technology and our ability to work with our electricity suppliers we have stabilized the situation and there should be no further loss in major plants.

An increase of 12 percent is substantial and could very well cause a further loss of a significant portion of the industry.

Mr. **MADIGAN**. But there isn't anything that says for every 10 percent increase in electric utility costs, these are the consequences in the industry? No one has worked that out?

Mr. **HAYMAKER**. I think we could make such an estimate, Mr. Madigan. In the end aluminum prices will determine whether you stay viable and they are volatile. They are intensely competitive but in terms of a specific quantification, I couldn't give it to you off the top of my head. Twelve percent is, however, a significant increase. It would completely offset, for example, the reductions we are hoping to gain through exploring new means of reducing our cost of service at our plant in Maryland which is very much threatened by its electricity rates.

Mr. **MADIGAN**. In earlier panels, electric utility executives said that the feature in this bill that is supposed to cap electricity rates at 10 percent really won't work and that that would apply to residential consumers only in any event, and that in the case of commercial users and industrial users, there could be increases. Depending on the utility company and the service region, there could be increases in the range of 25 to 30 percent.

How would you describe the impact of those kinds of increases on your industry?

Mr. **HAYMAKER**. They would be very, very serious. As I mentioned earlier, one-third of the cost of making aluminum is determined by the electricity cost going in and obviously, increases on that order of magnitude in the scheme of total costs are very, very large.

The cost of power to most foreign aluminum producers is in the range of 12 mils and in the United States the average for fossil fuel power is more in the range of 28 mils, more than twice. A 25- to 30-percent increase obviously is very dramatic.

Mr. **MADIGAN**. Is it possible for the industry to work out a reliable table that would say for every 10-percent increase in electricity costs, this would be the consequence on the American aluminum industry if all other things stayed the same?

Mr. **HAYMAKER**. I think we could easily work out a table that would show how our relative position in the world would deteriorate further. Today we know that the American industry is in the third quartile and some in the fourth quartile of world energy cost and production costs in total. That was shown in the Department of Commerce study. I think we can show clearly that a shift of the type we are talking about, changes like that, would move us well up the scale toward the very high end of the cost curve in the word.

Mr. **MADIGAN**. Would that study be able to show what that would mean in terms of job losses in the United States among other things?

Mr. Haymaker. I think one could draw such comparisons. Obviously, it is an estimate. Those decisions would be decisions taken by individual companies as to curtailment or shutdown of their facility.

Mr. Madigan. Would you be willing to undertake that to make it a part of our record and also give us a copy of the Commerce Department study that you referred to?

Mr. Haymaker. We will do our best, Congressman, yes.

[See p. 461.]

Mr. Madigan. Thank you. Dr. Masciantonio, you testified as to the impact of this legislation on the ability of U.S. industry as a whole to compete in foreign markets. Could you be more specific as to the types of industries you are talking about and the impact that you expect that this would have on these industries?

Mr. Masciantonio. It is difficult, of course, to speak for all segments of industry. The Business Roundtable, who I am representing today, represents the 200 largest major corporations.

I think the group that participated in the preparation of this testimony and whose remarks I am trying to reflect would be the heavy industry manufacturing segment. These are people who rely heavily on electricity for their product. These are people who would be faced with the imposition of further controls on their boilers and processes.

So I would confine that concern to the manufacturing segment of our organization.

Mr. Madigan. Thank you.

Mr. Waxman. Thank you, Mr. Madigan. Mr. Sikorski, I am going to recognize you at this point but I ask you before you begin your questioning, if you would yield to me.

Mr. Sikorski. Certainly.

Mr. Waxman. Gentlemen, so much of your testimony today on the cost to you and we heard this from earlier panels as well is based on an Edison Electric Institute report as to what they think the cost will be and we on Tuesday received the testimony from representatives of the Edison Electric Institute but I want to point out that we have also received a Congressional Research Service analysis of that EEI report and I would like by unanimous consent at this point to insert it in the record.

[Testimony resumes on p. 289.]

[Information to be furnished follows:]

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ESTIMATING ACID RAIN CONTROL COSTS:
ILLUSTRATIVE PROBLEMS FROM THE RECENT EEI-TBS STUDY OF H.R. 4567

Prepared at
Congressional Request

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April 29, 1986

ESTIMATING ACID RAIN CONTROL COSTS: ILLUSTRATIVE PROBLEMS FROM THE RECENT EEI-TBS STUDY OF H.R. 4567

SUMMARY AND CONCLUSION

In discussing the implications of potential acid rain control legislation, legislators and analysts naturally focus attention on control costs and their economic effects. In particular, interested parties examine projected electricity rate increases to residential and other electricity consumers. However, despite their importance, and the mounds of cost studies conducted, Congress is still faced with electricity rate projections that are sometimes an order of magnitude apart on the costs of controls.

The most recent example of this situation relates to H.R. 4567. The bill involves States meeting a 1.2 lb. of SO2 per million Btu statewide limit on utility emissions, along with other reductions by other industrial concerns, by whatever means States choose to comply. In introducing the bill, sponsors made explicit reference to provisions in the bill to help States prevent residential electricity rates from increasing more than 10 percent because of control equipment costs. This assistance comes in the form of an interest subsidy to be funded by a fee of 1/2 mill per kilowatt-hour (kwh) on non-nuclear, non-hydro power generated or imported into the country.

Four days after introduction, the Edison Electric Institute (EEI) released a study conducted by Temple, Barker & Sloane (TBS) stating that residential rate increases would be much more than 10 percent for many of the country's utilities--over 30 percent in the case of Kentucky Power Company. Regarding the interest subsidy, the EEI-TBS study suggested that no utility met the requirements of the interest subsidy despite the study's projected high residential rate increases.

Like most other things involved with the acid rain controversy, cost studies have a political content. Because one can vary the decision-making process, the provisions of the proposed program, and the necessary cost assumptions in conducting cost analysis, it is not always easy to tell if a study's result flows from prior stated assumptions, or from result-oriented procedures that have to be understood before the study's usefulness can be assessed. This is particularly true of a bill like H.R. 4567 which is designed to provide maximum flexibility to States in implementing its provisions and whose deadlines are well into the future.

The EEI-TBS report does not take advantage of the flexibility or opportunities for cost-effective or imaginative responses provided by H.R. 4567. This is somewhat paradoxical as utilities' concerns about constraints being imposed on how they could meet any acid rain requirement were a primary consideration to drafters of the bill in deciding to provide as much flexibility to States as possible in designing reduction strategies. Indeed, the compliance strategy chosen by TBS for the individual utility reanalyzed in this report was not the most cost-effective available to the utility. The implication of the EEI-TBS study that utilities would not seriously examine opportunities for innovative and cost-effective responses in designing reduction strategies under H.R. 4567 seems questionable in light of State concerns and the utilities own self-interest.

Utilizing some, but not all, of the flexibility provided by H.R. 4567, CRS analyzed one utility studied in the EEI-TBS report (Kentucky Power Company) and found compliance options necessitating rate increases substantially less than those projected by TBS. Using a range of possible control methods, CRS projected rate increases from Kentucky Power Company of between 4.3 percent and 10.4 percent first-year, and 1.8 percent and 6.5 percent average over 20 years. These results compare with a EEI-TBS estimate of an above 30 percent firstyear rate increase and a CRS recalculation of the EEI-TBS scenario of 24.2 percent first-year and 10.2 percent average over 20 years.

INTRODUCTION

In discussing the implications of potential acid rain legislation, legislators and analysts naturally focus on control costs and their effects. However, despite their importance, and the mounds of cost studies conducted, Congress is still faced with estimates that are sometimes an order of magnitude apart on the cost of controls. The introduction of H.R. 4567 illustrates this situation. In introducing the bill, sponsors made explicit reference to provisions in the bill to help States prevent residential electricity rates from increasing more than 10 percent because of control equipment costs. However, four days after introduction, the Edison Electric Institute (EEI) released a study conducted by Temple, Barker & Sloane (TBS) stating that residential rate increases would be much higher, over 30 percent in the case of Kentucky

Power Company. 1/

This paper attempts to provide insight on the potential and pitfalls of acid rain cost analysis, using the EEI-TBS study of H.R. 4567 as an example. Many of the points raised are applicable to virtually all acid rain cost studies. The discussion is divided into four generic areas: (1) How the study handled H.R. 4567's decision-making process, (2) How the study interpreted H.R. 4567's various provisions affecting costs, (3) Methodological issues (including scope and assumptions), and (4) An example from the EEI-TBS report. It should be noted that the issues raised in this analysis are illustrative, not comprehensive.2/ Also, the analysis assumes a working knowledge of H.R. 4567 on the part of the reader.

DECISION-MAKING

The central decision-making authority under H.R. 4567 is the individual State government. The State may become as involved in the reduction process as it desires, including choosing sources to be controlled, methods to be used, and how costs are to be distributed. With the bill's statewide bubble and no restriction on control methods, the State may choose the most cost-effective control strategy for its consumers; or, using the bill's interest subsidy provision, the State may choose to

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1/ Temple, Barker, & Sloane, Inc. Economic Evaluation of H.R. 4567: The "Acid Deposition Control Act of 1986". Prepared for the Edison Electricity Institute, April 14, 1986.

2/ For other cost-related issues in acid rain cost analysis, see Parker, Larry. Summary and Analysis of Technical Hearings on Costs of Acid Rain Bills. Prepared at the request of the Committee on Environment and Public Works, U.S. Senate. CRS unnumbered report, July 26, 1982.

trade some cost-savings to electricity consumers for high-sulfur coal production savings for its coal miners by installing some less cost-effective control technology. In either case, the State is in control.

Attempting to put the above political decision-making process into an economic analysis presents difficulties for cost analysts. Generally, the analyst must put himself in the place of the State government and make basic assumptions on how the bill would be implemented. In many studies, including the EEI-TBS study, the State role is generally ignored and the individual utilities are the focus point of the analysis. Depending on the analyst, individual utilities may or may not be adopting cost-effective strategies. For example, the EEI-TBS study assumes 74 gigawatts of flue gas desulfurization (FGD) capacity would be installed under H.R. 4567. (FGD is the generally the most expensive and capital-intensive control technology). This compares with 10-30 gigawatts of FGD projected by the Congressional Office of Technology Assessment (OTA) and ICF, Inc. for reductions of similar magnitude. 3/ Such a fundamental difference in the estimated proportion of utilities choosing one or another control method (particularly a capital-intensive method such as FGD) has a dramatic impact on rate estimates. Since TBS assumes twice as much FGD as other studies, it is not surprising that its projected costs are

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3/ The difference probably results from differing definitions of cost-effectiveness. OTA and ICF define cost-effectiveness in terms of the control method which is least-cost to the utility. In its study of H.R. 3400 conducted in 1983, TBS defined cost-effective FGD candidates as generating units of 200 megawatts or more built since 1960, or remaining units built since 1965. This assumption results in considerably more FGD being installed than an assumption based on least-cost to the utility. As suggested by the example of Kentucky Power Company presented later in this paper, TBS may have used a similar definition for this analysis.

higher, particularly during the first few years.

Hence, how the analyst views the actual decision-making process of acid rain bills influences his results. The EEI-TBS study uses utilities as the focus of the study with FGD as the primary control technique. Such a focus does not necessarily model the actual decision-making process under H.R. 4567; and, it certainly does not result in the most cost-effective strategy possible under the bill.

H.R. 4567 PROVISIONS

As written, H.R. 4567 is designed to provide maximum flexibility to the States in deciding how to reduce emissions. Important provisions in this regard include no restriction on control methods, a statewide emissions rate standard allowing bubbling 4/ of emission sources, and an interest subsidy for States who wish to protect their high-sulfur coal production without dramatic residential rate increases. As suggested above, this flexibility permits a State to choose a least-cost, polluter-pays strategy, if it wishes; or, to protect its high-sulfur coal production.

Models used by OTA, ICF, and Data Resources Inc. (DRI) permit analysts to incorporate much of the flexibility permitted by H.R. 4567 in their studies. Analysts still must guess the position of State Governments in deciding overall strategy as discussed above; however, one can run different scenarios to indicated how differing State policies affect costs. For example, a recent ICF analysis for the Environmental Protec-

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4/ A bubble permits a company (or State) to meet an average company-wide emission limit, rather than requiring compliance at each individual emission source.

tion Agency (EPA) contained two scenarios each for a six and eight million ton reduction: (1) least-cost only, and (2) least-cost but including 27.2 gigawatts of the most cost-effective FGD. 5/ Other studies have been conducted to include dry scrubbing and Limestone Injection Multi-stage Burners (LIMB) technology as additional control methods; these additional techniques are definite control possibilities for compliance with H.R. 4567, given the bill's 1997 compliance deadline for part 2. Different scenarios are not only useful in debating the cost of acid rain control, but also for identifying potential implementation strategies if such legislation is passed.

The EEI-TBS study incorporates little, if any, of the flexibility of H.R. 4567 in its analysis; it does not make use of the 1.2 lb. of SO2 per million Btus statewide bubble, the potential for new technology, or least-cost strategies. The study defines the interest subsidy provisions in such a way as to provide no relief to utilities because no one is eligible (by TBS's definition).

METHODOLOGY

Methodology and assumptions inevitably affect conclusions, sometimes in non-obvious ways. Five categories of variations are described below.

1. Definition of Cost: Definitions of what should be included as acid rain "control costs" have a substantial impact on estimated program costs. Generally, incremental capital, operations and maintenance costs, and fuel costs for pollution control equipment or fuel switching are accepted as reasonable expenditures to be charged to an acid rain program. However, other costs, such as replacement capacity or energy for scrubber retrofits, are considered more

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5/ ICF Incorporated. Analysis of 6 and 8 Million Ton and 30 Year/NSPS and 30 Year 1.2 lb. Sulfur Dioxide Emission Reduction Cases. Prepared for the Environmental Protection Agency, February 1986.

arguable. The EEI-TBS study mentions a 5.5 percent penalty for scrubber retrofits, but not how that penalty is assessed. The study also assumes that acid rain control would have an immediate and substantial price impact on the low-sulfur coal market, despite its current depressed state. Because of this assumption, the study assigns a cost premium to low-sulfur coal currently being burned by utilities.

2. Cost Estimates: Capital cost estimates for FGD used in acid rain analyses vary significantly: from $155 (TVA) to $450 (AEP) a kw in various utility studies. Similarly, premiums for low-sulfur coal also vary, from $0 to $30 a ton. The capital cost estimates used by TBS in their analysis are about 10-20 percent higher on average than EPA estimates. However, variable operations and maintenance costs used by TBS are almost 8 times greater.

3. Alternatives Available: Even through any acid rain program would not be fully implemented until the 1990s (the mid 1990s in the case of H.R. 4567), many acid rain analyses constrain their control alternatives to a couple of currently available technologies. Several technologies are emerging which may significantly reduce reduction costs. With the flexibility and relatively long lead times of H.R. 4567, this assumption is particularly important. The EEI-TBS study examines only three alternatives for control: wet FGD, fuel switching, and plant retirement.

4. Financial Parameters: If the acid rain strategy being proposed is capital-intensive, financial parameters can have a significant impact on apparent costs. This impact can be emphasized by the way the study's results are presented. The EEI-TBS study provides few details on its financial assumptions.

5. Presentation: There are several ways to present acid rain costs. If the acid rain control strategy being proposed is capital--intensive, first-year costs may be roughly double the average cost of the program over the life of the equipment. Also, because of the accelerated tax depreciation (ACRS) available, the first five-years of the program will be disproportionately higher than the rest of the program's life. A second aspect of presentation is the baseline chosen. For various reasons, many analyses present results in terms of rate increases from current or past rates. This method assumes that electricity rates will remain the same in real terms until the 1990s when the program would be implemented. The EEI-TBS focuses its presentation on first-year and five-year levelized costs and rate impacts. The base year used for the rate impact is not stated. No levelized rate impacts for the life of the equipment are provided.

AN EXAMPLE: KENTUCKY POWER COMPANY

In order to illustrate some of the considerations discussed above, a utility from the EEI-TBS study has been chosen for closer examination. The utility chosen is Kentucky Power Company (KPCo). KPCo is a 1097 megawatt utility with a two unit generating station--Big Sandy (unit 1: 281 Mw, 1963; unit 2: 816 Mw, 1969). Current SO2 emissions from the plant are under 2.0 lbs. per million Btus and within SIP requirements.

KPCo was chosen for this discussion for two reasons. First, according to the EEI-TBS report, KPCo will have the highest residential rate increase under H.R. 4567 at over 30 percent, showing that H.R 4567 would have very high costs for some utilities. 6/ Second, for the purposes of this discussion, the utility does not have some of the complexities of other systems because KPCo has only one power station and no stage 1 reductions.

Methodology Used

To provide some comparability between the EEI-TBS analysis and the alternative scenarios developed by CRS, this CRS study employs TBS's allocation formula for KPCo. Based on 1983 excess emissions above 1.2 lb. per mmBtus, TBS estimates that KPCo would have to reduce SO2 emissions by

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6/ It is interesting to note that KPCo was the utility projected in 1982 by American Electric Power to experience a 106.4% rate increase from acid rain legislation proposed at that time (S. 1706). The same reduction method used in this older analysis is used by TBS in the EEI-TBS study, although the rate increase has dropped. See American Electric Power Service Corporation. Economic Impact on the AEP System of Compliance with the Mitchell Bill, February 23, 1982.

16,393 tons under H.R. 4567 from a total of 44,574 tons. 7/ This works out to a system reduction of 37 percent.

To achieve this reduction, the EEI-TBS study assumes KPCo will install a wet scrubber on unit 2. Assuming proportionate emissions between the two units and 90 percent removal by the scrubber, this action would result in 29,841 tons of SO2 removed. This is considerably more than is necessary, given TBS's allocation formula--particularly since the EEI-TBS report does not incorporate H.R. 4567's statewide bubble, and therefore assumes the utility will not be able to sell the excess reduction. 8/

CRS developed five scenarios for KPCo to indicate the range of control possibilities available, and the influence of assumptions on costs. While these scenarios allow us to examine some of the issues raised above, they do not incorporate all the flexibility and cost effectiveness opportunities available in H.R. 4567. The scenarios are as follows: 9/

7/ It should be noted that this is not the allocation formula mandated under H.R. 4567 which has no baseline year or percentage reduction requirement. It is employed here only to provide some comparability between the EEI-TBS report and the scenarios presented here.

8/ Based on 1983 SO2 emission rates as developed by Energy Ventures Analysis, Inc. for Big Sandy, the EEI-TBS scenario would result in a company-wide emission rate of .6 lb of SO2 per million Btus. 1983 data from Energy Ventures Analysis, Inc. Evaluation of SO2 Emissions and the FGD Retrofit Feasibility at the 200 Top Emitting Generating Stations. Prepared for the U.S. Environmental Protection Agency, January 10, 1986.

9/ Based on 1983 SO2 emission rates as developed by Energy Ventures Analysis, Inc. for Big Sandy, the four CRS scenarios would result in a company-wide emission rate of 1.07 lb. of SO2 per million Btus--sufficient to meet the 1.2 lb of SO2 per million Btu average on a monthly basis as specified in H.R. 4567. 1983 emission rate data from Energy Ventures Analysis, Inc. Evaluation of SO2 Emissions and the FGD Retrofit Feasi-

Scenarios

1. EEI-TBS. This scenarios assumes the reduction strategy as employed by TBS in their analysis. Cost assumptions are the same as in the report; however, other assumptions, including NOx costs, replacement costs, and financial parameters have been changed to make them consistent with the other scenarios.

2. Adequate FGD. Under this scenario, unit 2 is equipped with a wet scrubber only sufficient to removed the SO2 required. With a 90 percent efficient scrubber, 55 percent of unit 2's stack gases are scrubbed. Such a strategy would require a scrubber with about 450 Mw capacity.

3. Dry Scrubbing. Dry scrubbing is a recent technology particularly suited to plants which burn low to medium sulfur coals, such as Big Sandy. With the dry scrubber operating at 50 percent removal, all of unit 2's stack gases would be scrubbed under this scenario.

4. LIMB Technology. LIMB (Limestone Injection Multi-Stage Burners) is a developmental technology which would probably be available for commercial use by the late 1980s or early 1990s. With 50 percent removal, all of unit 2's stack gases would be scrubbed under this scenario.

5. Fuel-Switching. Sited in the heart of eastern low-sulfur coal deposits, KPCo might very well decide to fuel-switch its facility to achieve the necessary reductions. Under this scenario, both unit 1 and unit 2 would switch their coal to compliance quality.

Assumptions

These five scenarios are compared with each other according to the below assumptions.

Wet FGD Costs. For the EEI-TBS scenario, CRS used TBS's assumption of $280 a kilowatt installed for capital costs. Operations and maintenance costs of $13 a kw for fixed costs and 1.7 mills per kwh for variable costs are assumed, as specified in the report. CRS assumes TBS's 1986 dollars are really end of 1985 dollars.

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bility at the 200 Top Emitting Generating Stations. Prepared for the U.S. Environmental Protection Agency, January 10, 1986.

For the Adequate FGD scenario, CRS used EPA estimates for a 500 kilowatt scrubber burning 1.67 lb. of SO2 per million Btu coal inflated by the GNP implicit price deflator to end of 1985 dollars and incorporating a 1.3 retrofit factor. This resulted in a $235 a kilowatt capital cost. Operations and maintenance costs were derived similarly (including a 1.3 retrofit factor for fixed O & M), and were $11.7 per kw for fixed costs and .22 mills per kwh for variable costs.

Dry Scrubbing Costs. For the Dry Scrubbing scenario, CRS used EPA estimates for a 500 kilowatt dry scrubber operating at 50 percent efficiency and burning 1.67 lb. of SO2 per million Btu coal inflated by the GNP implicit price deflator to end of 1985 dollars and incorporating a 1.3 retrofit factor. This resulted in a $125 a kilowatt capital cost. Operations and maintenance were derived similarly, and were 1 mill per kwh.

LIMB Costs. For the LIMB scenario, CRS used EPA estimates for a 500 kilowatt LIMB system operating at 50 percent efficiency and burning 1.67 lb. of SO2 per million Btu coal inflated by the GNP implicit price deflator to end of 1985 dollars. This results in a $50 a kilowatt capital costs. Operations and maintenance were derived similarly, and were .7 mills per kwh.

Coal Price Differential. Current coal price differentials for low-sulfur coal range from $0 a ton to $5 in the current market. Under an acid rain bill, the demand for low sulfur coal could drive this differential back up to previous levels of $5 to $10 a ton. For this analysis, CRS assumed that the differential would be $10 a ton by the time the 1997 compliance deadline appeared.

Upgrading Costs. Switching Big Sandy to even lower-sulfur coal than it already burns might involve adjustments to the boiler or ancillary equipment such as grinders or the plant's ESP. For this analysis, CRS assumed that these costs were $10 a kilowatt.

Financial Parameters. Based on DOE data and CRS estimates, table 1 summarizes the financial assumptions made about KPCo. 10/ From these assumptions, nominal and real capital charge rates were calculated--16.5 percent nominal, 11.8 percent real. All calculations are in constant end of 1985 dollars.

Table 1: Financial Assumptions for Analysis

Return on Equity	14 percent
Average Weighted Cost of Debt	10 percent
Debt ratio	60 percent
Nominal Discount Rate	10 percent
Real Discount Rate	5 percent
Percent of Investment as AFUDC	10 percent
Property Taxes/Insurance	2 percent
Equipment Service Life	20 years
Tax Depreciation	5 year ACRS

Electricity Demand. CRS assumed that KPCo electricity demand will increase at 1 percent a year from its 1984 levels during the 20 year life of the program.

NOx Costs. Big Sandy's NOx emissions are approximately .8 lbs. of NOx per million Btus. With a reduction of only 25 percent necessary for KPCo to meet H.R. 4567 NOx requirement, it is not clear that the $10 a kilowatt low-NOx burners assumed by TBS in 75 percent of all cases would

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10/ Department of Energy. Financial Statistics of Selected Electric Utilities, 1984. DOE/EIA-0437(84). January 1986.

be necessary in this case. Therefore, for the purposes of comparison, NOx costs were not included in this analysis.

This deletion does not represent a major cost item. Assuming KPCo chose to use low-NOx burners to achieve its reduction, a retrofit of unit 2 would be sufficient. Assuming TBS's $10 a kw cost estimate, this scenario would result in a .66 percent first-year rate increase and a .17 percent 20-year levelized rate increase. For readers which wish to include this NOx scenario to the SO2 scenarios presented later, the results are additive. However, the NOx cost should not be added to the LIMB scenario as that technology is a simultaneous SO2 and NOx reduction technology.

Replacement Capacity. Using EPA estimates, the capacity loss under the Adequate FGD scenario would be about 20 megawatts. CRS has assigned no cost to this loss in capacity because of the short and long term reduction in demand the increased costs of electricity from the retrofit would bring. Even if one assumes a low -.2 electricity price elasticity in the short-term and -.5 in the long term, the short and long term rate increases projected for this scenario should cause demand reductions sufficient to "replace" the capacity lost to the retrofit. 11/ Hence,

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11/ While electricity price elasticities for the residential sector are generally accepted to be -.2 (short-term) and -.7 (long-term), commercial and industrial elasticities are more uncertain. There is evidence that commercial electricity demand is elastic, more so than in the residential sector. On this point, see Parker Larry B. "Commercial Consumption", in J. Schanz. U.S. Energy Outlook: A Demand Perspective for the Eighties. A report for the Committee on Energy and Commerce, U.S. House, July 1981. There is also evidence that the industrial elasticity in the long-term is in the range of -.5 to -1.0 Hence, to be conservative, we have assumed inelastic short-term and long-term price elasticities of -.2 and -.5 respectively. For a general discussion of energy elasticities, including electricity price elasticities, see Bohi, replacement costs probably should not be charged to H.R. 4567 in this case. The same is true for the EEI-TBS scenario, and is so analyzed in this paper. Capacity losses under the Dry Scrubbing and LIMB scenarios would be about half those under the Adequate FGD scenario or less than 1 percent of KPCo total capacity. As with the FGD cases, it is assumed the demand reduction would be sufficient to cover the minor loss in capacity.

Results

Using a utility cost model developed by CRS, and assuming January 1, 1985 residential rates for KPCo as published by DOE 12/, table 2 presented projected first-year and 20-year levelized residential rate increases under the various scenarios. As indicated, the LIMB scenario is the least-cost strategy under the assumptions of this analysis, while the EEI-TBS scenario is the most expensive.

Table 2: Residential Rate Increases Under Five Scenarios

	Scenario				
	EEI-TBS	Adequate FGD	Dry Scrubbing	LIMB	Fuel Switching
First-Year Rate Increase	24.2%	10.4%	9.6%	4.3%	7.8%
20-Year Levelized Rate Increase	10.2%	4.0%	3.5%	1.8%	6.5%

Douglas R. Analyzing Demand Behavior: A Study of Energy Elasticities. Published for Resources for the Future, Baltimore: John Hopkins University Press, 1981.

12/ Department of Energy. Typical Electric Bills, January 1, 1985. DOE/EIA-0040(85) December 1985.

Several observations can be made. First, the CRS recalculation of the EEI-TBS scenario results in a considerably reduced first-year rate impact than that reported in the actual report--24.2 percent versus over 30 percent. There are probably several reasons for this difference. The primary reason is likely the removal of replacement costs from the analysis. As noted earlier, the EEI-TBS mentions a 5.5% energy and capacity penalty in discussing its key financial assumptions. However, the report does not explain how it accounts for this penalty in terms of additional costs. Also, as noted previously, the EEI-TBS study includes costs for low-NOx burners, which this comparison does not. (Although as calculated earlier, this is only a minor cost addition.) Differences may also arise from different financial parameters, although there is no way of assessing the impact as they are not presented in the EEI-TBS report.

Second, this example suggests that the EEI-TBS report is not strictly based on a least-cost implementation strategy, although H.R. 4567 provides that flexibility. The EEI-TBS study states that its assumed utility decision order for achieving SO2 reductions is fuel switching first, scrubbing second, and retirement last. Such an order would suggest some roughly based cost-effectiveness criteria. However, assuming the EEI-TBS scenario presented here represents the scrubbing decision in the EEI-TBS report, it seems clear under the assumptions of this analysis that KPCo should follow the first decision and fuel-switch its plant to achieve the reduction under H.R. 4567. The cost differential identified in table 2 would be even greater if EEI-TBS study results were correct.

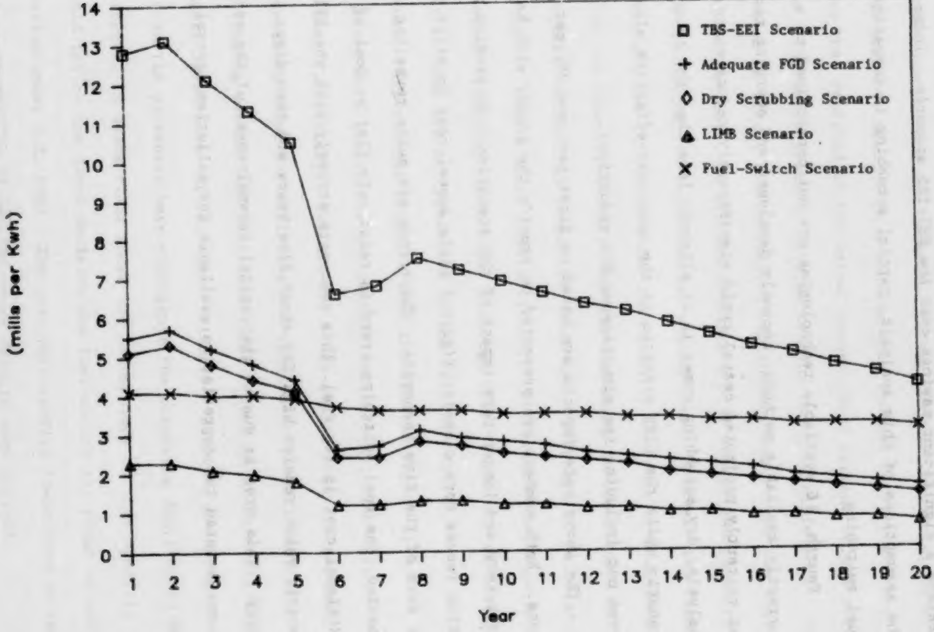
A third observation which can be made is that if scrubbing is scaled back to that adequate for the H.R. 4567 reduction, the utility can achieve a significant savings over the EEI-TBS scenario. Indeed, under the assumptions of this analysis, partial scrubbing is competitive with fuel switching.

Fourth, if available technologies are not constrained to a couple of currently available methods, recently developed and emerging technologies (at currently projected costs) could significantly reduce costs. In this analysis, dry scrubbing comes in at slightly less than the Adequate FGD scenario while the LIMB scenario is the most cost-effective alternative (even not including its simultaneous NOx reduction).

The above rate impacts are based on first-year and 20-year levelized costs. Both numbers are presented to provide the reader with both the short-term and longer-term impact of the scenarios. To examine presentation issues more closely, figure 1 plots annual cost in mills per kwh for each of the five scenarios. The trends are quite revealing. As expected, the fuel switching trend is relatively flat as most of the additional cost is for fuel. This contrasts strongly with the EEI-TBS scenario which remains high for about five years and then drops significantly. This drop is due to the capital intensiveness of the scenario and the accelerated tax depreciation available for pollution control equipment.

Figure 1: Reduction Cost for Scenarios

(annually, mills per Kwh)



Mr. Waxman. It indicates EEI did not really analyze H.R. 4567. Instead, EEI reviewed a bill it created to meet its own conclusions. The EEI report is full of faulty assumptions, strained reasoning and ridiculous conclusions.

Let me just point out a few of them. CRS projects rate increases from Kentucky Power Co. of between 4.3 and 10.4 percent the first year and 1.8 and 6.5 percent average over 20 years. Those results differ dramatically from EEI's estimate of over 30 percent first year rate increases and a 10-percent increase over 20 years.

The EEI analysis does not take advantage of the flexibility or opportunities for cost effective or imaginative responses provided by the bill. EEI ignored the bill's provisions regarding flexibility of control methods, a statewide emission rate standard allowing bubbling and an interest subsidy for states wishing to protect high sulfur coal production.

EEI calculated worst case cost scenarios that they would be unlikely to pursue in the real world. They assumed 74 gigowatts of scrubbing capacity when this is not required by the bill and it is the most expensive and capital intensive technology. This estimate compares with 10 to 30 gigowatts of scrubbing projected by OTA and ICF.

EEI used the scrubber capital cost estimate of $280 per kilowatt when TVA has reported that scrubbers can be installed for 155 kilowatts. This higher assumed cost would necessarily drive up the cost of the bill. EEI defines the interest subsidy provisions in such a way as to provide no relief to utilities because no one is eligible.

EEI defines the word debt to include only interest owed and not capital owed.

The point I am making in this to you and to other witnesses is that if you don't do your own independent analysis and rely on the EEI study, you are relying on a discredited report to us as to the costs and if you use that cost basis——

Mr. Luken. Mr. Chairman.

Mr. Waxman. Just a minute.

Mr. Luken. Mr. Chairman, you are describing something that we don't have the benefit of.

Mr. Waxman. We certainly do have the benefit of it and we will make it available.

Mr. Luken. I don't have it.

Mr. Waxman. If the gentleman will permit me to conclude my marks, if you use that as the basis for your cost of electricity then you should realize you are relying on a discredited analysis. They didn't analyze the bill but they created a biased report which pyramided the cost and allows it to be exaggerated.

For the gentleman's information from Ohio, the CRS study will be handed to you and it has been made a part of the record.

Mr. Madigan. Will the gentleman yield?

Mr. Waxman. Certainly.

Mr. Madigan. I thank the gentleman for yielding and I would just quickly like to add to your comments that if we annualize the cost of these various estimates over a 20-year period of time, the EEI estimate on an annual basis comes up at $5.4 billion. The OTA estimate ranges from $3.8 to $4.9 billion per year and the EPA estimate is a range from $4 billion to $6 billion a year.

So if we annualize this over a 20-year period, the EEI estimate is right in the ball park with the OTA estimate and the EPA estimate and I thank the gentleman for yielding.

Mr. **Waxman**. I disagree with that because then it seems to me if you take those figures from EEI, then the OTA and the ICF report analysis would be a much lower one.

Mr. **Luken**. Mr. Chairman.

Mr. **Waxman**. Yes, Mr. Luken.

Mr. **Luken**. This is mind boggling, and the reason, of course, is that we are rushing to judgment on this whole thing. This is a bill that has very recently been introduced. It is horribly complex and the authors did not create the complexity, but obviously in the usual cycle this bill would have been introduced months ago and these various reports that we are now getting that are flying past us, reports upon reports, would have an opportunity for more mature consideration and analysis.

As I pointed out, Mr. Chairman, I did not have the benefit of this and, obviously, I can't comment on it since it is just handed to me but I would just like to comment for the benefit of the panel that the chairman's comments that the EEI report is discredited is a matter of opinion at least as of the present time.

Mr. **Waxman**. I am submitting the opinion of the Congressional Research Service. We have the opinions of OTA. We have the ICF study which is going to be even more final according to the testimony of the representative of the Environmental Protection Agency and I am amazed at this charade saying, "Oh, my gosh, a bill has just been introduced. How could we move forward with a bill that has just been introduced?"

My friend from Ohio introduced a whole redoing of the Clean Air Act in December of one year and then wanted us to move it in 6 months time. We were already sitting and marking it up in a very short period of time. It was based on, I am sure he would contend, a lot of information that preceded it and this legislation is based on information that preceded the introduction of the bill and we are now having the opportunity for hearings to evaluate it.

I would also point out that we have a Fuel Use Act amendment being proposed and marked up immediately. There is nothing wrong with it. If a bill is ready to be moved, we should move it. If we have good legislation, we ought to have hearings, get opportunity for input but we want an honest opinion of what is going on and not a biased one that is going to distort the whole legislation.

Mr. **Madigan**. Mr. Chairman.

Mr. **Waxman**. Mr. Madigan, do you wish to be recognized?

Mr. **Madigan**. Well, we have a vote and the second bells have rung.

Mr. **Waxman**. Then let's respond to the vote.

Mr. **Luken**. Mr. Chairman, could I have 10 seconds?

Mr. **Waxman**. Ten seconds and then we are going to respond to the vote.

Mr. **Luken**. On this point in view of the chairman's comments about the EEI report and the fact that it has been referred to here rather consistently, it would be a logical thing to have the EEI authors here to testify next week.

Mr. Waxman. We have already had the authors of the EEI report.

Mr. Madigan. If the gentleman would yield, why didn't we attack them while they were here? We did we let them leave and now are attacking them so they can't respond?

Mr. Waxman. Gentlemen, we are going to have representatives from the utilities back here next Wednesday and we are certainly going to pursue that issue with them. Let's stand adjourned for just so long as it takes us to respond to the vote and return.

Let me just ask, are there other questions that Mr. Luken or others—are there questions of this panel that you have? We will come back to accommodate you. Do you want to let them go and then we will take a break for lunch?

Mr. Madigan. No. Let's lock them up for the weekend.

Mr. Scheuer. Mr. Chairman.

Mr. Waxman. Mr. Scheuer, did you have some questions you wanted to ask of this panel? If you do, we will vote and come back.

Mr. Scheuer. Look, I don't want to hold up eight or nine guys for my questions.

Mr. Waxman. They are getting paid.

Mr. Scheuer. In courtesy and with respect, if I could have unanimous consent to address some questions to them in writing and hold the record open, that might be a way of solving my problem.

Mr. Waxman. Certainly. We already agreed to that earlier and I think that is perfectly appropriate.

Mr. Quarles. Mr. Chairman, would you give me 10 seconds to make just one brief point?

Mr. Waxman. I am sorry, Mr. Quarles. We have a vote on the House floor so we are going to respond to that and you can put a point in writing in the record and we will put it in there later.

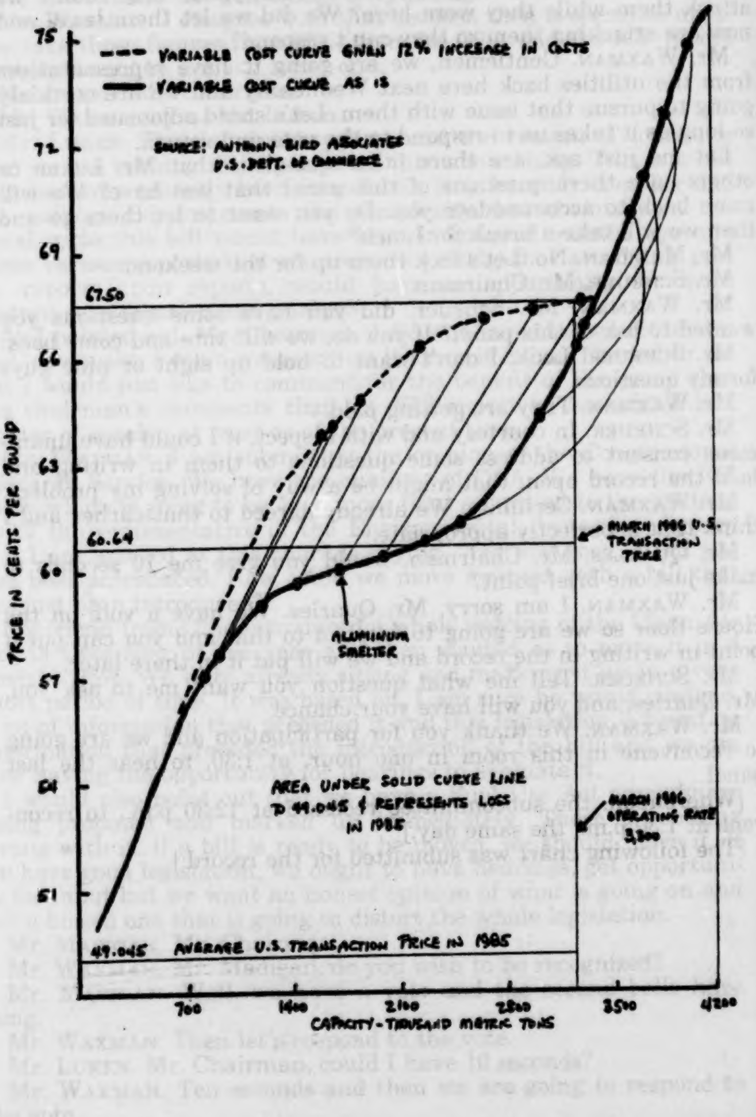
Mr. Scheuer. Tell me what question you want me to ask you, Mr. Quarles, and you will have your chance.

Mr. Waxman. We thank you for participation and we are going to reconvene in this room in one hour, at 1:30, to hear the last panel.

[Whereupon, the subcommittee recessed at 12:30 p.m., to reconvene at 1:30 p.m., the same day.]

[The following chart was submitted for the record:]

ACID RAIN IMPACT ON ALUMINUM INDUSTRY



EXPLANATION OF THE VARIABLE COST CURVE - ACID RAIN IMPACT ON THE ALUMINUM INDUSTRY

The solid line on the attached chart represents the current estimated variable costs of operation for U.S. smelting plants.

The broken line shows the increase in variable costs at the plants affected by H.R. 4567.

The dots represent aluminum smelters which derive their electricity from fossil fueled power plants.

The average U.S. transaction price in 1985 (49.045¢), the March 1986 U.S. transaction price (60.64¢), and the estimated price that those plants affected by H.R. 4567 would need to cover the increased costs of operation.

Two main conclusions are apparent:

1. A substantial segment of the U.S. industry is only marginal, given current costs.
2. A very significant portion of the industry would become unprofitable if the costs of H.R. 4567 are imposed.

In addition, the average market price reported by Metal Week for the last 8 years is 60.3¢ per pound. It is therefore highly unlikely that any of the increased costs which would result from the enactment of H.R. 4567 could be passed on to customers.

THE ALUMINUM ASSOCIATION **Revised 5/15/86**

AFTER RECESS

Mr. **Waxman.** The meeting of the subcommittee will come back to order. For our last panel today I would like to call forward and welcome Dr. Robert I. Bruck, associate professor, plant pathology and forestry, School of Forestry, North Carolina State University; Mr. Paul Emler, director, field operations, Living Lakes, Inc.; Mr. Myron Uman, staff director, Environmental Studies Board, National Academy of Sciences; and Mr. Don Etchison, director, Illinois Department of Energy and Natural Resources.

We are pleased to have you with us. Your prepared statements will be made a part of the record in full and we would like to ask you to summarize your statement in no more than 5 minutes and we are going to be very strict on the 5-minute rule using our trusted alarm clock.

Dr. Bruck.

STATEMENTS OF ROBERT I. BRUCK, ASSOCIATE PROFESSOR, PLANT PATHOLOGY AND FORESTRY, SCHOOL OF FORESTRY, NORTH CAROLINA STATE UNIVERSITY; PAUL EMLER, JR., DIRECTOR, FIELD OPERATIONS, LIVING LAKES, INC.; MYRON F. UMAN, ON BEHALF OF NATIONAL RESEARCH COUNSEL, NATIONAL ACADEMY OF SCIENCES AND NATIONAL ACADEMY OF ENGINEERING; AND DON ETCHISON, DIRECTOR, ILLINOIS DEPARTMENT OF ENERGY AND NATURAL RESOURCES

Mr. **Bruck.** Thank you, Mr. Chairman. I have submitted my written testimony and it is quite lengthy and I would like to spend a short amount of time summarizing some key points and emphasizing data that is just analyzed and new that I think is pertinent in perhaps understanding the issue of forestry effects in acid deposition.

A third year of scientific investigation addressing the etiology and epidemiology of boreal montane forest decline has been completed. Due to a large scale decline of 10 forest tree species in Central Europe much attention has been focused on the question of whether or not the same phenomenon is in progress across high altitude ecosystems in the Eastern United States.

The unique nature of many of the observed symptoms, including the synchronized appearance of same, and the location of the affected forests in areas of high anthropogenic pollutant deposition, make it plausible that airborne pollutants may, in part, be responsible for the forest decline.

Air pollution damage to forests is not new and this must be emphasized. As the industrial revolution gathered momentum in the latter part of the 19th century, many point sources of pollution were responsible for high levels of atmospheric contaminants.

Trees and other vegetation have been dying near metal smelters, chemical plants, refineries, and fossil-fuel-fired plants for more than 100 years. Forests in central and eastern Europe have been suffering periodically from smoke damage since the middle of the 19th century. The smoke usually consists of sulfur dioxide, oxides of nitrogen and heavy metals along with soot, ash and dust from coal-fired industrial processes, metal smelters and power plants.

However, and I emphasize however, such damage was usually found close to heavily industrialized, urban areas. It was seldom generalized over entire regions as is being seen in the Waldsterben in central Europe and forest decline in high altitude ecosystems of the Eastern United States.

In order to address an important observation as to whether or not forest decline is limited in its scope to industrialized regions, for the past 3 years I have undertaken as a research objective to visit high altitude spruce-fir ecosystems throughout North America, Europe, and Asia to determine whether or not there is a consistent incidence of forest decline in those areas.

Beginning in 1983 permanent observation plots were established in the Black Forest of West Germany, the southern Appalachian Mountains, the Mount Hood area of Oregon's Cascade Mountains, the Gothic Mountain-Gunnison area of the Colorado Rocky Mountains, the Alaska Range surrounding Mount McKinley in Alaska and the Mount Everest Solu-Khumbu region of the Himalayas of Asia.

High elevation boreal montane conifer stands were selected in each one of these regions to represent a typical western facing aspect for each respective sampling site. Upon plot establishment using techniques similar to the southern Appalachian Mountain survey dominant and co-dominant trees were rated for their physical condition or appearance and increment cores were taken for dendrochronological analysis.

In addition, surface soil samples from 0 to 3 centimeters were collected using a mass per unit area measurement for the determination of nutrients and toxic metals.

Figure 28, which appears on page 60, my written testimony illustrates a summary of the average percent of symptomatic trees, those trees exhibiting more than 11-percent defoliation from the six regions that were explored. Through the assistance of colleagues studying the forest decline, Waldsterben syndrome, in West Germany it was determined that approximately 49 percent of trees in the sampled area of the Black Forest exhibited symptoms of Waldsterben, indicating that these fell into the greater than 11-percent defoliation category.

Studies conducted by the two authors of this testimony in the southern Appalachian Mountains have indicated that on west-facing slopes approximately 38 percent of all trees scored in 1985 were categorized as declining. Quite contrary to the observations made in both the southeastern United States and West Germany, observations from the Cascades of Oregon, the Rocky Mountains of Colorado, the Alaska range of Alaska, and the Mount Everest region of the Himalayas indicated that only between 2 and 9 percent of all trees exhibited visual decline symptoms.

It must be remembered that these decline symptoms include stress from all biotic and abiotic agents present on these sites. We would expect that natural endemic or background levels of pest and pathogens in the environment would exhibit between 5 and 10 percent stressed individuals on all sites.

The relative health of particularly the pristine Himalayan forests was unusual to observe.

Figure 29 on page 61 illustrates the average 5-year combined annual radial increment measurements for tree growth in the same regions as described above. The only exception is that relatively high elevation trees from the Calcarius Alps of southern Germany were used for the core analysis.

It is interesting to note that for the areas of West Germany and the southern Appalachian Mountains during the period of 1955 to 1960, an abrupt decrease or shift in lower annual increments were observed. On all other sites, these shifts were not observed.

In the final figure—figure 30—is illustrated the amount of lead, surface soil lead, in the environment.

[Testimony resumes on p. 365.]

[The prepared statement of Mr. Bruck follows:]

CONGRESSIONAL TESTIMONY

Dr. R. I. Bruck
Dr. W. P. Robarge

May 1, 1986

THE FOREST DECLINE ENIGMA- IS IT AIR POLLUTION RELATED?

A statement prepared for presentation to the

United States House of Representatives Committee on Energy

and Commerce Subcommittee on Health and the Environment

May 1, 1986

by

Dr. Robert Ian Bruck
Associate Professor of Plant Pathology and Forestry

and

Dr. Wayne P. Robarge
Assistant Professor of Soil Science

North Carolina State University
Raleigh, N.C. 27695

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EXECUTIVE SUMMARY

A third year of scientific investigation addressing the etiology and epidemiology of boreal montane forest decline has been completed. Due to a large scale decline of 10 forest tree species in Central Europe much attention has been focused on the question of whether or not the same phenomenon is in progress across high altitude ecosystems in the eastern U.S. The unique nature of many of the observed symptoms, including the synchronized appearance of same, and the location of the affected forests in areas of high anthropogenic pollutant deposition, make it plausible that airborne pollutants may, in part, be responsible for the forest decline.

A preliminary reconnaissance of Mt. Mitchell, N.C. (2,038 m) and surrounding ridges was undertaken in 1983 to observe and photodocument decline symptoms on red spruce (Picea rubens Sarg.) and Fraser fir (Abies fraseri (Pursh.) Poir.). Twenty-two ridge top plots were established along the Black Mountain Range. Decline assessments of dominant and co-dominant trees were made, increment cores were removed, along with foliage and surface soil samples. Initial findings suggested that a significant decline of both species was taking place particularly at higher altitudes. Trees sampled above 1900 m exhibited marked growth reduction beginning in the early 1960's. Feeder roots on both symptomatic and asymptomatic trees were in a poor condition, along with the deterioration of the ectomycorrhizae (essential root-fungus symbiotic relationships). Based on these initial results, a comprehensive survey was initiated in May 1984 to quantify and characterize the extent of forest decline throughout the Southern Appalachians. A series of 40 permanent plots were established on 8 mountains from Mt. Rogers in Virginia to Clingmans Dome (Great Smoky Mountains National Park). In each of the 1 ha circular plots decline and dieback assessments were made by utilizing a computer generated key. Stand descriptions were made and a complete ecological assessment of the overstory (tree), shrub and herbaceous strata undertaken. In addition a pathological assessment of fungi and insects was made on all trees falling in the plot, fine feeder roots were collected to assess the presence of root pathogens and ectomycorrhizae, 2 increment cores were extracted from 5 dominant or co-dominant trees of both species and all trees were tagged and mapped. Soil samples (including the forest floor) were obtained on a mass per unit area basis to a depth of 12 cm in 4 cm increments and foliage clipped by growth year in the Fall of the year. All the above procedures were again repeated during the summer and fall of 1985.

Analysis of the 1984 data indicated that the spruce-fir decline syndrome is observed in varying degrees throughout the Southern Appalachian Mountains. West-facing slopes appear to have greater decline and dieback incidence along with more pronounced ring increment suppression. The 1984 data also indicated that low altitude red spruce were generally healthy exhibiting only 21% of individuals in "diseased" decline classes, high altitude spruce exhibited 32% diseased individuals. The observations made during the 1985 resurvey of the 1984 plots revealed a significant deterioration in the condition of the boreal ecosystem. Only 49% of the low altitude spruce and 41% of the high altitude spruce remained in the "healthy" category following only 1 year of elapsed time. Individual tree mortality increased by 7% across all plots.

Eighty-two percent of all red spruce sampled exhibited marked and synchronous annual ring suppression beginning in the 1958-1963 period. Westward facing trees (predominant wind direction) exhibited greater increment suppression and decline symptomalogy.

Of great interest is the fact that these high altitude ecosystems are bathed in cloud moisture 7 of every 10 days throughout the year. Atmospheric chemists have indicated that pollutant concentrations at cloud base (the part that intercepts tree crowns) are highly concentrated, and could account for both nutrient and toxic substance accumulations.

Needle samples collected from Fraser fir and red spruce trees growing on six different mountain tops in North Carolina were analyzed for 28 macro- and micronutrients and trace elements (N, P, S, Ca, Mg, K, Cu, Fe, Mn, Zn, Co, Al, Ba, Br, Ce, Cl, Cr, Cs, Hg, La, Na, Ni, Pb, Rb, Sb, Sc, Sm and Th). Comparison of the results of these analyses with previously reported elemental analyses of Fraser fir and red spruce indicated no significant nutrient deficiencies occurring in the dominant and codominant trees sampled, except for calcium. The mean concentration of calcium observed in red spruce needles (1440 mg/kg, n=30, 1984 growing season) fell below that reported for red spruce foliage in the northeastern United States (1830-7900 mg/kg). Calculated Ca:Mg ratios (1.44 - 2.97, 1984 growing season) were also lower than those calculated from published results for red spruce foliage in the Northeast (3.00 - 5.62), suggesting that the concentration of calcium in red spruce needles in the southern Appalachian Mountains may be approaching values thought to be deficient for good growth. The concentration of calcium in Fraser fir foliage (3350 mg/kg n=41, 1984 growing season) was also lower than reported values (1200-7700 mg/kg), but not to the extent demonstrated for red spruce trees.

One anomally observed in the foliar nutrient data was a lack of a decrease in nitrogen concentration with increasing age of red spruce needles (1.05, 1.13, 1.07% for 1984, 1983, 1982 flush years, respectively). Such a decrease would be expected for a mobile element like nitrogen, and is observed for phosphorus, magnesium and potassium. The lack of a decrease in nitrogen concentration with increasing needle age suggests an increase in the availability of nitrogen, either in the soil or via foliar uptake of atmospheric nitrogen.

Analysis for the foliar concentration of such elements as mercury, arsenic and selenium yielded results at or below the detection limits for the techniques employed (0.010, 0.050, and 0.1 mg/kg, respectively). Lead was found to be present in the analyses of both red spruce and Fraser fir needles, with Fraser fir generally having higher concentrations, particularly in the older needles (0.65, 2.86, and 2.78 mg/kg, N=41, for 1984, 1983, and 1982 flush years, respectively). Comparison of lead concentrations with those of other rare-earth elements known to be associated with dust on needle surfaces (cerium, lanthanum, scandium, samarium and thorium) suggests that a substantial portion of the lead found was due to particulates on the needle surfaces and not to uptake and translocation from the roots into the needle tissue. The higher concentrations of lead associated with Fraser fir versus red spruce needles may be due to differences in needle morphology and chemical composition of the waxy cuticle.

Elemental analyses of soil samples from the spruce-fir ecosystem revealed that the soils under the spruce-fir forests are highly variable, making comparisons between locations and elevation gradients very difficult. Differences in the concentration of elements measured (P, K, Ca, Mg, Mn, Fe, Al, B, Cu, Zn and Pb) were detected between stands and mountain locations, but in most cases these differences appear to be the result of differences in the mineral content of the soil samples. Based on the total number of soil samples collected in this study, it appears that the forest floor in the spruce-fir stands sampled is approximately 8 cm thick, with substantial mixing of forest floor and underlying mineral soil in the lower 4 cm. Only Mt. LeConte, GSMNP, demonstrated a forest floor that seemed comparable in thickness (> 12cm) to those of the spruce-fir forests of the northeastern United States.

Comparison of stands with approximately the same proportion of soil organic and mineral matter suggested differences in lead content with elevation, but within stand variability prevented any definite statement from being made in this regard. Comparison of the mean values for concentration and mass per unit area for copper, zinc and lead yielded no significant differences in these elements as a function of elevation or aspect for the stands sampled at Mt. Mitchell, NC. Copper was found to be significantly higher in the soil from the northwest stand on Roan Mountain, NC, an observation that is consistent with the fact that this stand is downwind from Copper Ridge, TN.

Substantial amounts of lead were found in the forest floor of the spruce-fir forests of the southern Appalachian Mountains. However, lead is also present in the underlying mineral soil because of the lead content of the original rock from which the mineral soil was derived. Lack of a clear separation between the forest floor and underlying mineral soil leads to an overestimation of the amount of lead deposited by atmospheric processes by simply summing the mass of lead found in the top 12 cm of soil. Cesium-137 and lead-210 were used to provide an estimate of the extent of incorporation of Pb from anthropogenic sources into the soil profile. A correction factor was then applied for the lead extracted from the mineral matrix of the surface soil samples. This approach yields estimates of total lead deposition of between 600-1300 mg/m^2 for the spruce-fir forests in the southern Appalachian Mountains. This estimate is only 40-50% of that reported for similar ecosystems in the northeastern United States (1800-2000 mg/m^2). However, further work is needed to generate the necessary database in order to determine whether the deposition of lead in the mountains of the southern United States is in fact less than that in the northeast.

Collection of soil samples during this study was on a mass per unit area basis by fixed depth increment without regard to soil horizons. This sampling scheme was chosen because it was assumed that the thickness of the forest floor within the spruce-fir forest of the southern United States would be approximately equal to the spruce-fir forests of the northeast. Our results demonstrate that this assumption is not valid for the southern ecosystems, and that sampling by an arbitrary fixed depth increment only compounds the natural variation already present within these stands. We recommend that future studies which include soil characterization as part of their objectives consider sampling on a mass per unit area basis within horizons. Such an approach will allow for differences in the chemical environments between horizons but still provide an estimate of the total amount of an element (such as lead) present within the total depth sampled. We also recommend that future studies focus on soil chemical procedures that yield information directly applicable to predicting tree growth and to not attempt total dissolution of soil sampled.

Due to the restriction of the forest decline to areas of known high pollutant deposition it seems likely that an extraordinarily complex disease syndrome is in fact taking place. A scenario might involve various forms of concentrated pollution being deposited via cloud deposition, causing above and below ground nutrient and microbial imbalances or direct physiological aberrations to spruce and fir trees. These chronic perturbations could lead to a predisposition of the ecosystem, to the effects of many indigenous pathogens and insects, and/or weaken the trees' resistance to the effects of severe climate. Continued research to integrate the findings of long term studies with relevent atmospheric monitoring data will create a clearer picture of the potential of atmospheric pollution to affect American forest resources.

HISTORICAL PERSPECTIVES ON FOREST DECLINE

Air pollution damage to forests is not new. As the Industrial Revolution gathered momentum in the latter part of the 19th Century, many point sources of pollution were responsible for high levels of atmospheric contaminants. Trees and other vegetation have been dying near metal smelters, chemical plants, refineries, and fossil fuel-fired power stations for the past one hundred years or more. Forests in Central and Eastern Europe have been suffering periodically from "smoke damage" since the middle of the 19th Century. The "smoke" usually consists of sulfur dioxide, nitrogen oxides, and heavy metals, along with soot, ash, and dust from coal-fired industrial processes, metal smelters, and power plants. However, such damage was usually found close to heavily industrialized, urban areas; it was seldom generalized over entire regions.

In recent years the pattern of pollution in Eastern Europe has changed dramatically. Czechoslovakia, in particular, has become very heavily polluted. Total gaseous emissions jumped from 3.6 million metric tons in 1960 to 7.3 million metric tons by 1980, an increase of more than 100 percent. The amount of sulfur dioxide generated in 1980 was 3.2 million metric tons, while 1.6 million metric tons of nitrogen oxides were also produced along with 500,000 metric tons of hydrocarbons. As a result of these various facts, Czechoslovakia is now among one of the most intensely air polluted countries in the world. On average, about eight metric tons of atmospheric pollutants per inhabitant are generated annually. The same is true for the heavily industrialized parts of Poland and East Germany, which are known to have large areas of "smoke" damaged forests. In an effort to combat the damage, Poland has been experimenting with pollution-resistant trees for the past 15-20 years.

Gaseous pollutants, like sulfur dioxide, hydrogen fluoride, and ozone, have played prominent roles in past declines, but their destructive effects have been relatively "localized," or limited to specific areas under continuous assault from airborne pollution. As early as 1910-11 damaged trees (mostly lodgepole pine and Douglas fir) were investigated in the Deerlodge National Forest located near the Washoe metal smelter at Anaconda, Montana. They were found to be suffering, in part, from sulfur dioxide pollution, which retarded their growth. Similarly, ozone has damaged or killed thousands of ponderosa and Jeffrey pines in the San Bernardino Mountains east of Los Angeles, California, a city famous for its yellow-brown photochemical smog. A U.S. Forest Service survey carried out in 1969 revealed that some 1.3 million ponderosa pine growing on 405 square kilometers in the San Bernardino National Forest were stressed and dying. In areas with the highest ozone concentrations, timber yield was found to be reduced by 80 percent or more. Today, both ponderosa and Jeffrey pines have been seriously damaged or killed over wide areas in the San Bernardino Mountains, resulting in a markedly altered forest ecosystem.

However, natural stresses like drought, frost, and winter damage along with biotic factors such as insect infestations, fungi, and other disease organisms have probably figured prominently in most large-scale forest declines of the past. Between 1871 and 1880, for example, red spruce forests from New York State to New Brunswick, Canada were devastated by what has since been attributed to a combination of drought conditions and insect attacks.

Historically, most forest damage was limited to one or two agents, or a combination of several; in nearly every case there were visible "smoking guns." Moreover, the damage was usually localized or, if regional, involved only a few species. Never before has such large-scale and rapidly spreading forest decline been observed affecting so many different species under such varied ecological conditions. Over the past 50 years there have been 19 major or minor regional forest declines in Europe and North America. Of these 19 reported declines, at least seven implicate air pollutants as a primary, or at least a contributory, cause. With one exception, all of the pollution-related declines developed (or at least were noticed) within the last eight years. Increasingly, the finger is being pointed at airborne chemical pollution as the major cause of forest decline and death, however no proof has been offered.

DAMAGE TO FORESTS

Waldsterben in Central Europe is, by far, the most complicated and serious forest decline on record. Dr. Peter Schutt, Professor of Forest Botany and Pathology at the University of Munich and Dr. Ellis Cowling, Associate Dean for Research at the School of Forest Resources at North Carolina State University in Raleigh, have produced a comprehensive description of Waldsterben. The following features of the "disease" and its extent are noteworthy:

1. Visible symptoms of Waldsterben began around 1979-80 in many different parts of Europe and within four years the "disease" had spread over large areas of the continent.

2. As of late 1985, Waldsterben was still increasing in intensity and geographic distribution and is associated with an alarming frequency of damage from secondary stress factors such as insects, needle and root fungi, and climatic stresses (i.e., frost, wind, and snow damage).

Pollution-Related Forest Declines

Widely assumed major role:

- Waldsterben in Europe
- Decline of ponderosa and Jeffrey pines in the San Bernardino Mountains, California
- Regional decline of white pine in the eastern United States and Canada

Possible major role:

- Decline of red spruce, and balsam, and Fraser firs in high elevations in the Appalachian Mountains from Georgia to New England
- Growth decline without other visible symptoms in loblolly, shortleaf, and slash pines in the Piedmont regions of Alabama, Georgia, North and South Carolina
- Growth decline without other visible symptoms in pitch and shortleaf pine in the Pine Barrens region of New Jersey
- Widespread dieback of sugar maples in northeastern United States and southeastern Canada

Declines Related to Biological or Physical Factors

- Tannensterben (white fir decline) in Europe
- Kiefersterben (Scotch pine decline) in East Germany and European Russia during early 1970s
- Oak decline in Germany and especially in France since early 1900s
- Decline of *Pinus pinaster* on the Atlantic coast of France since early 1980s
- Beech bark disease of northeastern United States and southeastern Canada
- Littleleaf disease of shortleaf pine in the southeastern United States
- Birch dieback in the northeastern United States and southeastern Canada

- Poleblight of western white pine in the Rocky Mountains
- Maple decline in the northeastern United States and southeastern Canada
- Oak decline in Pennsylvania, Virginia, and Texas
- Ash dieback in the northeastern United States and southeastern Canada
- Sweetgum blight in the southeastern United States

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3. Within five years it affected nearly every tree species in central Europe including the four most commercially important conifers (spruce, fir, pine, and larch) and six angiosperms (beech, birch, oak, ash, maple, and alder).
4. Various species of shrubs and herbs have been damaged in certain affected forests.
5. The symptoms are heterogeneous from one region to another, from one stand to another, and even within the same species in the same stand.
6. Waldsterben occurs with similar intensity on poor and rich soils, acid and basic soils, and on wet and dry soils, independent of their geological origin.
7. The symptoms often are more severe in high elevations, but they occur in middle and low elevation sites as well.
8. Different forest management practices and the composition of the forest (i.e., single versus mixed stands, planted vs. natural) do not appear to have a significant impact on the amount of damage.
9. Young trees are normally not as severely affected as older ones, but even this varies from region to region.
10. Some of the typical symptoms have never been described before (especially for beech, spruce, and larch).
11. The worst damage appears in higher elevation forests on slopes facing the prevailing winds.
12. Most of the victims show both growing-decreasing and abnormal growth symptoms.

The Waldsterben phenomenon is characterized by three broad indicators of destruction: growth-decrease, abnormal growth, and water stress.

Cowling cautions that although the common symptoms of Waldsterben include increased susceptibility to biotic and abiotic stress factors, this dieback pattern is very different from the normal diseases induced by familiar biotic forest pathogens-fungi, bacteria, nematodes, insects, and viruses. It is also distinct, from the typical injuries to forests induced by drought and frost, or by gaseous air pollutants like ozone and sulfur dioxide.

Paul Manion from the State University of New York helps to understand the complex interactions involved in forest declines. In his scheme, stress factors fall into three categories: predisposing, inciting, and contributing. Predisposing factors include climate, soil condition (moisture and nutrient supply), long-term atmospheric deposition of pollutants, and the genetic makeup and age of the tree. The effects of predisposing factors are generally asymptomatic. Inciting factors produce visible symptoms of injury. These include such abiotic stresses as drought and frost damage; biotic stresses like insect defoliation; and the short-term impacts from toxic gases (i.e., ozone, sulfur dioxide, etc.). These injure the tree and cause a relatively rapid deterioration of its condition. Because of the interaction of the other two factors of decline, trees become susceptible to severe damage from abiotic stress agents like drought, frost, and wind damage as well as the usual biotic stresses: insects, nematodes, fungi, mycoplasmas, bacteria, and viruses. Most of these agents may have been present always, but had little previous impact until the tree was weakened by predisposing and inciting factors. It is also interesting to note the overlapping role played by different stress agents. Drought, for example, can be a factor in all three categories.

The array of symptoms and the speed with which entire stands are affected suggests that the causes are multiple. Waldsterben, along with the North American decline, most certainly cannot be attributed to a single factor or even several factors. Emerging evidence points to the combined effects of a number of pollutants and natural factors working synergistically, antagonistically, or in an additive manner. Cowling states Regional declines of forests on both continents are believed to result from the combined action of several different competitional, biological, physical, and chemical stress factors that act simultaneously or sequentially to induce the symptoms of damage.

The scientific community still continues to debate the role of air pollution and acid deposition in the European and North American forest decline syndromes. Is air pollution only a preconditioning factor? An inciting factor? A contributing factor? Or all three? Is it a primary agent? A secondary agent? Or both? And all this is further aggravated by the fact that so little is known about how forest trees respond to different kinds of stress factors.

Since the symptoms of Waldsterben in Europe and the regional declines of certain conifers in North America vary, the research efforts on opposite sides of the Atlantic also differ. Nevertheless, the two forest decline syndromes have a number of disconcerting similarities. Recent research has revealed that the coniferous forests in both North America and Europe have been under continuous stress for the last three decades. Increment cores taken from thousands of conifers over the past few years show that their annual growth rings have become markedly narrower since 1970 as compared to the 1950s and 1960s. Growth declines of up to 20 percent have been observed in red spruce, and loblolly, shortleaf, and pitch pines in the eastern United States. In some severe cases, as on Mount Rogers in Virginia and on Mount Mitchell in North Carolina, the growth rates of red spruce and Fraser firs have been severely stunted. The radial growth of red spruce on Mount Mitchell and a few other sites has decreased an average of 82 percent, a fivefold drop since the 1960s (when compared to the period 1950-60).

In Europe, diameter growth reductions began in white fir about 1960, followed by Norway spruce (circa 1970), and seem to have started in European beech as of 1978-80.

These "invisible" growth symptoms, undetected until recently, occur long before the visible health of the tree begins to break down.

There are other connections too. In both Europe and North America the most severely damaged trees are those found consistently on higher elevation slopes facing the direction of the prevailing air masses, particularly those shrouded in clouds or fog much of the time.

Another disturbing aspect of Waldsterben-one more piece of circumstantial evidence pointing to air pollution stress-is the fact that mixed stands of trees are more damaged than monocultures. Air currents can penetrate the canopies of mixed forests more easily, while it takes longer for air masses to invade monocultures, where the trees are all roughly the same height (except at higher elevations and in steep terrain).

A growing number of U.S. scientists fear that the eastern forests of North America may soon experience Waldsterben-like symptoms over wide areas.

SOUTHERN APPALACHIAN SURVEY

In May of 1984 an extensive survey was begun to quantify and characterize the extent and rate of high-altitude red spruce/Fraser fir decline in the Southern Appalachian mountains. Initial results indicate that decline symptomatology is observed in varying degrees throughout the boreal ecosystem. West facing slopes appear to have greater decline incidence along with greater annual ring increment suppression (which was observed on 82% of all dominant and co-dominant red spruce sampled in the survey).

During the months of April-June 1985 a resurvey of all 1984 permanent plots was undertaken using the same decline rating scale employed in 1984. The percentage of trees exhibiting decline symptomatology in 1985 is significantly higher than that observed in 1984. The most significant shift in observed classes was in red spruce where 88% of the trees was scored as class 1 (healthy) in 1984 and only 49% of these trees remained in this class in 1985. In addition it was observed that all "decline" rating classes had significant increases for both red spruce and Fraser fir in 1985.

It seems apparent that a rapid deterioration in the appearance of Southern Spruce/fir ecosystems is in progress, however it must be emphasized that no known cause and effect mechanisms have yet been elucidated to comprehensively explain this forest decline. The high incidence of cloud impaction and pollutant deposition although correlated to decline symptomatology may be causal or coincidental in the observed syndrome.

MATERIALS AND METHODS

A preliminary reconnaissance of Mt. Mitchell N.C. (2,038 m) and surrounding ridges was undertaken in October 1983 to observe and photodocument decline symptoms on red spruce (*Picea rubens* Sarg.) and Fraser fir (*Abies fraseri* (Pursh.) Poir.). Twenty-two ridge-top plots were established along the Black Mountain Range. Decline assessments of dominant and co-dominant trees were made, increment cores were removed at DBH, foliage from the most recent year's (1983) needle whorls was removed, and surface soil samples (0-2 cm and 2-4 cm) including feeder roots were excavated.

Based on our initial findings (Bruck, 1984) a more intensive series of permanent plots were established during the summer of 1984 on six of eight explored high altitude boreal ecosystems in the Southern Appalachian Mountains (Fig. 1). These plots were revisited during the spring and summer of 1985 to continue assessments of decline symptomatology.

Stand Selection. Twenty-five to one-hundred year-old stands were selected for sampling. The primary selection criterion was that the vegetation composition of the stand be representative of the community on a given aspect of a given peak as determined by visual inspection. The secondary criterion was that the tree canopy within the stand should be as intact as possible in order to obtain a sufficient number of live trees per plot for statistical analyses. As a consequence of the second criterion, selected stands typically exhibited the least Balsam wooly aphid impact (on fir) for a given community. Contrasting stands were sampled at both high and low elevations on a given peak when an elevational difference within the spruce-fir zone of at least 150 m between high and low stands could be obtained.

Stand and Plot Establishment. Stands selected for sampling were 1-ha circular areas in horizontal projection. Decline and dieback assessments in each stand were made within three randomly located 30 x 4 m rectangular permanent plots. These plots were oriented radially around stand center at a random azimuth and distance, with over-sampling of stand center minimized through a transformed random number table. A tape was laid out to mark the center line of a plot. Slope angle was determined with a clinometer and used to adjust plot length to 30 m horizontal distance. The sampling area of a plot extended 2 m horizontally on each side of the plot center line. Forty centimeter orange plastic survey stakes were used to mark the endpoints of each center line, as well as the center of the stand.

General Stand Description. After establishing the center point of a stand, a general description of the stand was written; this description included a list of the species in the tree and shrub layers and dominant species in the herb layer. In addition, the general slope and aspect of the stand, height of the tree canopy, indications of logging or fire and any striking topographic and landform features, were noted.

Plot Description. Departures from the general stand description were noted for each plot. Arborescent individuals were classified as trees if their diameter at breast height (DBH) was $\geq$ 10 cm, as saplings if they were $\geq$ 2 m in height but < 10 cm DBH and as seedling if they were < 2 m in height. Each live tree within 2 m of the center line of a plot was marked with a serially-numbered aluminum tag placed at 1.3 m from the ground. Height of tag location was determined as the average of two measurements taken along the contour on opposite sides of the tree. DBH of a tree was measured immediately above this tag. The location of each tree was recorded to the nearest 0.5 m along the long and short axes of the plot.

Species, DBH, crown class, and dieback and decline ratings also were recorded for each tree. Dieback and decline were only assessed on red spruce and Fraser fir. Dieback was assessed on a 10 point scale (1 = 0-10%, 2 = 11-20%, etc.) and was measured as a percent loss of live crown length from the top and outside of the crown. Decline was assessed on a 4-point scale (1 = 0-10%, 2 = 11-50%, 3 = 51-90% and 4 = 91-99%) and was assessed as percent foliage loss from the lower, inner crown, upward, (Fig. 2). Percent foliage loss was determined by first estimating the proportion of crown length affected and then determining the number of years of needles retained within the affected portion of the crown. Normal needles retention time for red spruce was assumed to be 6 yr while that for Fraser fir was assumed to be 5 yr.

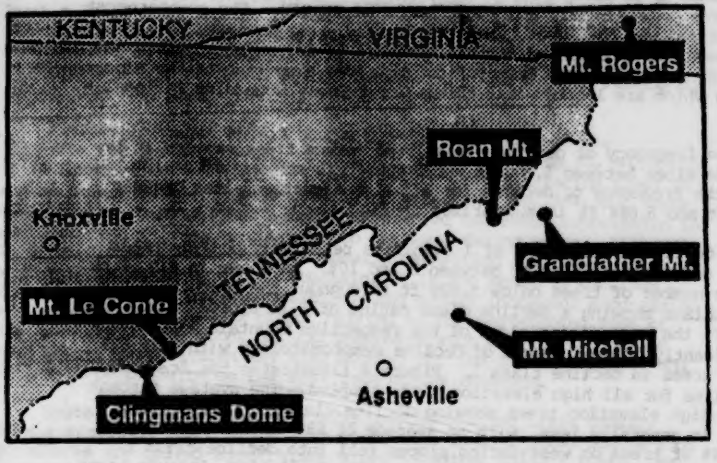
The presence of fungal pathogens, insects and mechanical breakage was noted for each tree. When evaluating fir trees, any tree which received a decline or dieback rating greater than 1 was checked for signs of the Balsam wooly aphid by examining the bole for the presence of wool and branches for the presence of gouting.

Fine feeder roots were collected from selected trees to assess the presence of root pathogens and ectomycorrhizae.

Two increment cores were taken from each of the 5 dominant and largest codominant trees on each plot. Cores were taken just below breast height on opposite sides of the tree along the contour.

All dead trees on a plot were recorded by species, if possible, and their diameter measured. Saplings were recorded by species and an estimate of height made to the nearest meter. For both red spruce and Fraser fir saplings, decline and dieback assessments were made using the same rating schemes as for trees. Estimates of seedling density for all arborescent species were obtained using six 1 m^2 subplots placed 3 m outside the plot at distances of 8, 16 and 24 m along its long axis.

Figure 1. Map illustrating the locations of permanent plot establishment in 1984. Mountains were selected based on abundance of spruce-fir forest type, and differences in parent material composition.


KENTUCKY
VIRGINIA
Mt. Rogers
Roan Mt.
Knoxville
TENNESSEE
NORTH CAROLINA
Grandfather Mt.
Mt. Le Conte
Mt. Mitchell
Asheville
Clingmans Dome

RESULTS AND DISCUSSION

During the 1984 field season, permanent plots were established on six of eight mountain areas visited (Fig. 1). The northernmost area studied was Mt. Rogers in Virginia. Moving southward, plots were established on Grandfather Mountain, Roan Mountain, Mt. Mitchell, Clingman's Dome (GSMNP), and Mount Le Conte (GSMNP). The southernmost site visited was the Joyce Kilmer Wilderness area, however, permanent plots were not established at this site due to a lack of suitable stands of red spruce and Fraser fir. This was also true of the Plott Balsams which are located east of the Great Smoky Mountains National Park.

The frequency of decline for all red spruce trees sampled at low altitude sites between 5,200 ft and 5,600 ft is summarized in Fig. 3, while the frequency of decline for all high elevation sites between 5,600 ft and 6,684 ft is summarized in Fig. 4.

A decline class rating of 1 signifies relatively healthy trees with a defoliation index of between 0 and 10%. As shown in Fig. 4 the average number of trees below 5,600 ft throughout the southern Appalachians showing a decline class rating of 1 is approximately 79%. However, the west-facing slope of the respective mountainsides have a significantly greater amount of decline symptomatology with only 62% of the trees in decline class 1. Figure 4 illustrates the frequency of decline for all high elevation sites sampled. The average percent of the high elevation trees showing decline class 1, i.e., healthy trees, is generally less, with an average of 68% in this category. Only 54% of trees on west-facing slopes fell into decline class 1, thus indicating that approximately one-half of all high altitude trees exhibited some decline symptomatology. Figures 5-7 illustrate the same trend for Fraser fir.

Increment cores were removed from only dominant and co-dominant red spruce and Fraser fir trees. Figures 8-9 illustrate growth trend during a preliminary survey conducted in Nov. 1983. Figures 10-14 outline the results of this increment core analysis on Mt. Rogers, Roan Mountain, Grandfather Mountain and both high and low elevation sites on Mt. Mitchell in 1984. On these mountains there was an abrupt and synchronous suppression of annual growth of both Fraser fir and red spruce beginning in a window period of approximately 1958-1965.

However, we consistently found that red spruce was in a much more serious state of growth suppression than was Fraser fir at all sites. Perhaps the most abrupt increment suppression observed was on Mt. Rogers in Virginia. Although the amount of visible decline here was the least of the sampled sites, increment suppression was found in all the spruce sampled, with approximately a five-fold decrease in radial increment since 1960 as compared to the annual increments from 1950 to

1960.

The overall frequency of red spruce increment suppression averaged approximately 82%. The lowest incidence of approximately 43% was found in the low elevation red spruce trees on Mt. Mitchell. The definition of severe increment suppression used in this study is at least a 2-1/2 fold decline in the average annual increments of 1960-1070 as compared to 1950-1960. Virtually all red spruce trees showed some slowing of growth during this period; however, many natural factors such as the natural aging process can account for a relatively slower growth rate.

Figures 15 and 16 show a comparison between high and low elevation red spruce growing at east and west aspects on Mt. Mitchell. It is interesting to note that not only are westward-facing trees in a more severe state of decline as illustrated in Figs. 3-4, but there also appears to be greater amount of relative increment suppression in westward-facing trees as compared to eastward-facing trees. Although this correlates with higher atmospheric deposition loading on the windward-facing slope of the mountain, it is too early to conclude that, in fact, decline symptomatology and growth increment suppression are necessarily cause and effect related to the west-facing side of the mountain. Many other natural phenomena such as wind damage and more severe temperatures may also account for the greater decline and increment suppression on the west face of the mountain.

Roots of spruce, pines and other needle-bearing trees usually show a symbiotic association with beneficial fungi. These fungus-root structures are called mycorrhizae (myco = fungus, rhiza = root). We observed a statistically significant correlation (P = 0.05) between the percent of spruce short roots that are mycorrhizal and the elevation at which the tree was growing (Figs. 17, 18). Trees growing above 6,350 feet averaged about 35% mycorrhizal incidence and spruce at or below 5,200 feet averaged about 72% mycorrhizal incidence.

When percent mycorrhizal roots were plotted against the degree of decline of the host tree, a highly significant correlation coefficient (P =0.01) was found. Trees exhibiting 80% or more defoliation (spruce at high altitudes) averaged about 30% mycorrhizal roots, whereas trees with few decline symptoms averaged about 75% mycorrhizal roots.

High altitude red spruce roots exhibited a far greater degree of disintegration (fine root necrosis) than did the creamy white, fungus mantle covered, tree roots found at low elevation.

Root isolations made from declining (high elevation) and non-declining (low elevation) red spruce trees revealed at least two species of the fungal root pathogen Pythium spp. Roots of vigorous trees at low elevation often failed to yield pathogenic fungi.

On certain west-facing slopes above 6,350 feet we observed little successful fir, spruce, or shrub reproduction. The ground was often barren of woody vegetation. West-facing slopes on the mountain below this altitude showed normal reproduction and were heavily colonized with seedlings and saplings of all age classes. By contrast, a vegetation survey in 1959 (A. Cooper, pers. comm.) showed that all aspects on Mt. Mitchell from the summit down had lush and abundant ground covers at that time. Figures 19-21 report data from our balsam wooly aphid survey collected from all Fraser fir in the decline survey. These data indicate that using our 4-point scale most trees (> 75%) did not express symptoms of aphid attack.

1985 PERMANENT PLOT RE-SURVEY

During the months of April-June, 1985 a field crew was dispatched to re-survey all 1984 permanent plots established on Mt. Mitchell, Roan Mountain, Mt. Rogers, Grandfather Mountain, Clingmans Dome, and Mt. Le Conte. The identical decline rating scale technique was employed during this 1985 survey.

The percentage of trees exhibiting decline symptomatology in 1985 is significantly higher than that observed in 1984 (Table 1). The most significant shifts in observed classes was in red spruce where 88% of red spruce were observed as "healthy" class 1 in 1984, and only 49% were observed in class 1 during the 1985 re-survey. In addition, it may be noted that all disease classes, i.e. classes 2, 3, and 4 (dead), had significant increases in 1985 as compared to 1984.

In conclusion, a rapid deterioration of high altitude spruce-fir ecosystems appears to be taking place in the Southern Appalachian Mountains. Rate parameters for ecosystem damage will require at least one more year of re-survey, however, it must be emphasized that at this time no known cause and effect mechanisms have yet been elucidated to comprehensively explain the observed forest decline syndrome.

Due to the restriction of the forest decline to areas of known high anthropogenic deposition it seems likely that an extraordinarily complex disease syndrome is in fact taking place. A scenario might involve various forms of concentrated pollution being deposited at high altitude, principally via cloud deposition, causing above and below ground nutrient and microbial imbalances or direct physiological aberrations in spruce and fir trees. These chronic perturbations could lead to a predisposition of the ecosystem to the effects of many indigenous pathogens and insects, and/or weaken the trees' resistance to the effects of severe climate at high altitude.

By integrating the findings of long term research programs with relevant atmospheric monitoring data a clearer picture of the potential of acidic deposition effects on forest ecosystems may be

realized. Much correlation, but no proof of the effects of air pollutants on spruce-fir ecosystems exists. Pointing fingers at specific pollutants and using them as scapegoats for decline amelioration may prove to be both costly and scientifically irresponsible.

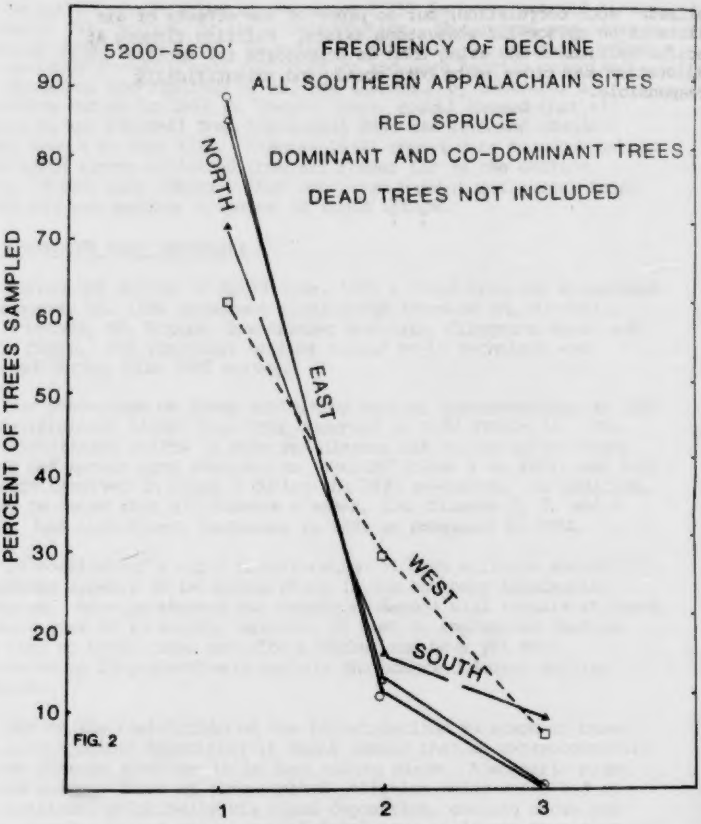


FIG. 2

Figure 3. 1984 survey results for all low-elevation red spruce in the six mountain survey. Most trees were observed in class 1 (healthy); only west facing aspects exhibited greater decline symptomatology.

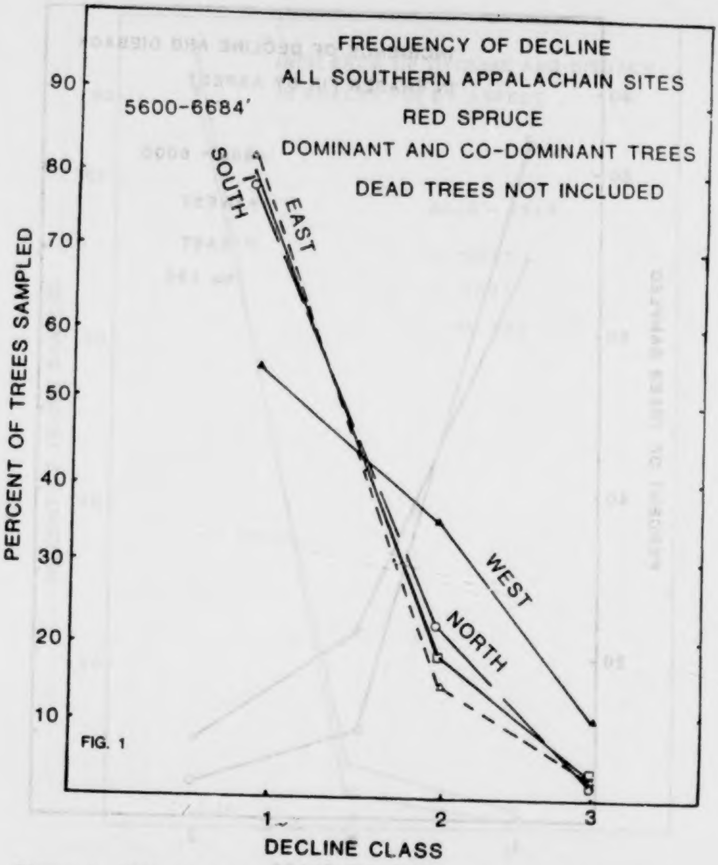


FIG. 1

Figure 4. 1984 survey results for all high-elevation red spruce in the six mountain survey. Most tress were observed in class 1 (healthy); with west facing aspect trees again exhibiting more decline symptoms like low elevation trees sampled.

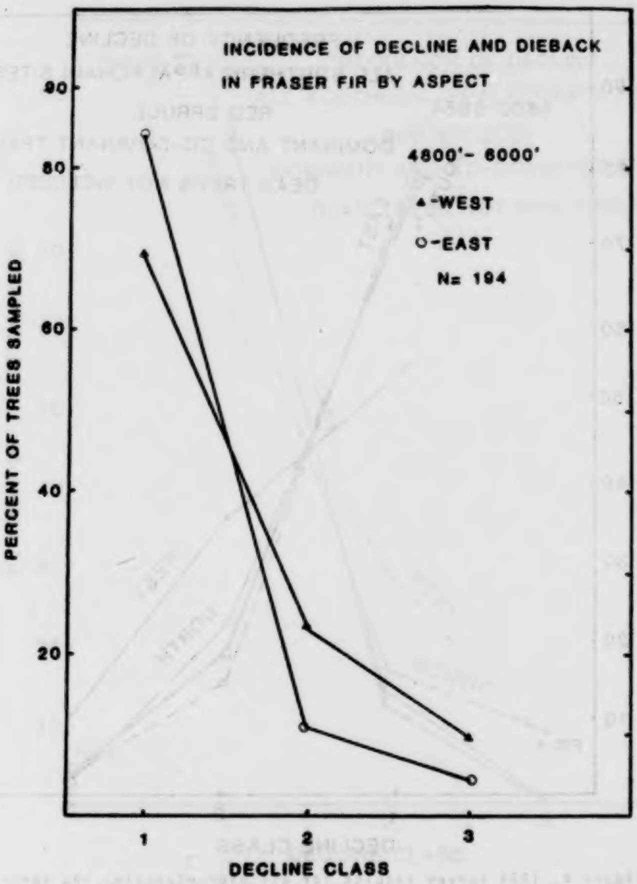


Figure 5. 1984 Fraser fir low-elevation decline class spectrum. West-aspect individuals exhibited greater decline symptomatology.

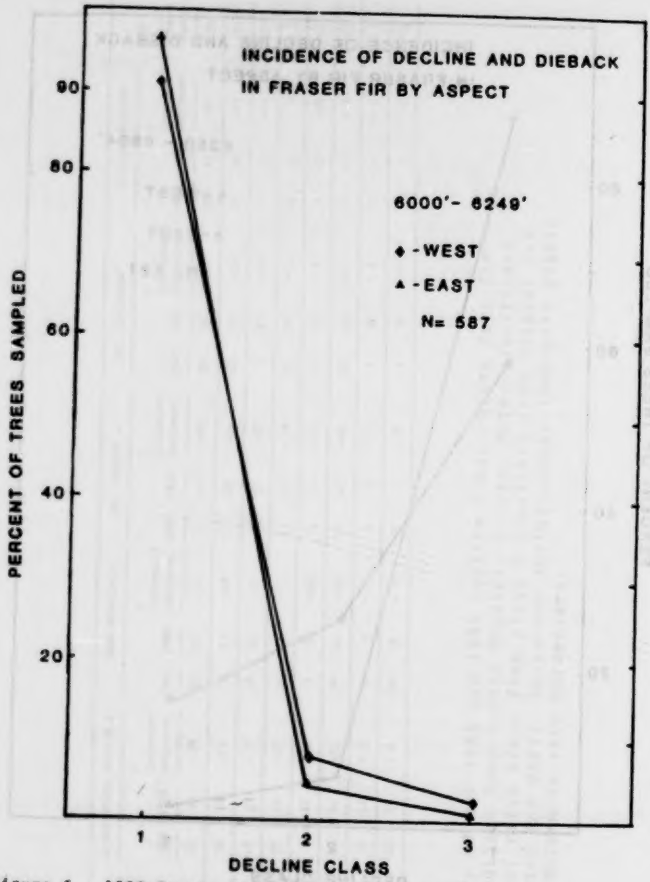


Figure 6. 1984 Fraser fir mid-elevation decline class spectrum. No significant difference was observed between east and west aspects.

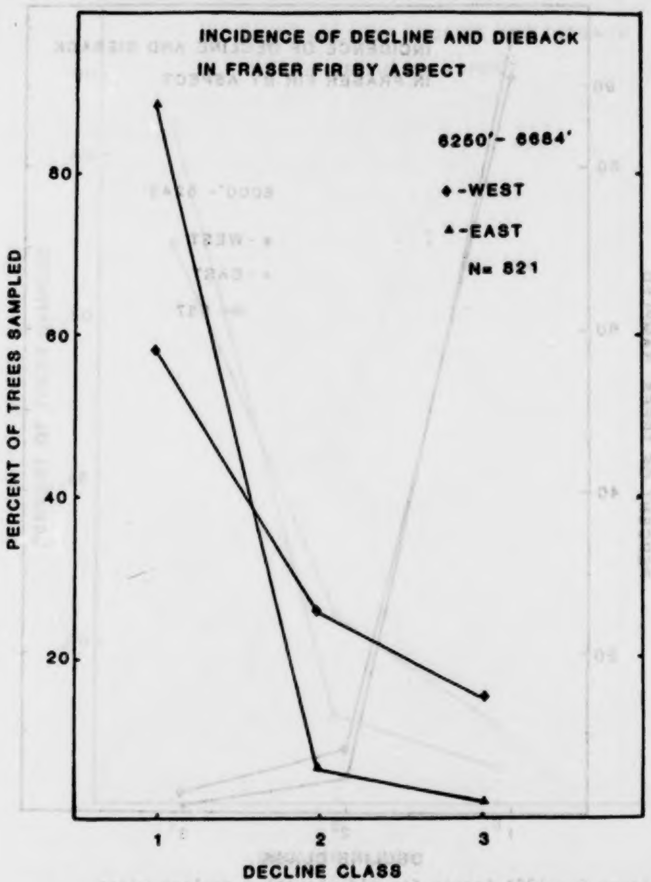


Figure 7. 1984 Fraser fir high-elevation decline class spectrum. West facing aspects exhibited greater decline symptomatology.

		Mt. Mitchell			Grandfather Mountain			Roan Mountain			Mt. Rogers			Mt. Le Conte			Clingmans Dome			Avg. % Total Change
		1984	1985	% Increase/ Decrease	1984	1985	% Increase/ Decrease	1984	1985	% Increase/ Decrease	1984	1985	% Increase/ Decrease	1984	1985	% Increase/ Decrease	1984	1985	% Increase/ Decrease	
% Class 1	Red Spruce	78	34	-44	81	42	-39	83	27	-56	91	52	-39	89	68	-21	90	61	-29	-38
	Fraser Fir	60	25	-35	25	10	-15	31	13	-18	57	26	-31	63	51	-12	79	60	-19	-22
% Class 2	Red Spruce	20	59	+39	16	9	- 7	14	51	+37	8	31	+23	5	27	+22	7	22	+15	+22
	Fraser Fir	15	5	-10	35	18	-17	24	21	- 3	17	25	+ 8	23	25	+ 2	13	21	+ 7	+ 8
% Class 3	Red Spruce	2	0	- 2	3	37	+34	3	19	+16	1	14	+13	5	2	- 3	3	13	+10	+11
	Fraser Fir	25	60	+35	30	63	+33	29	41	+12	21	42	+21	10	18	+ 8	4	13	+ 9	+18
% Dead	Red Spruce	0	7	+ 7	0	12	+12	0	3	+ 3	0	3	+ 3	1	3	+ 2	0	4	+ 4	+ 5
	Fraser Fir	0	10	+10	10	19	+ 9	16	25	+ 9	5	7	+ 2	4	6	+ 2	4	6	+ 2	+ 6

Table 1. Summary of all 1984 and 1985 decline class rating data for EPA Southern Appalachian Mountain Survey. Note- significant shift of rated trees from class 1 (healthy) into classes 2-4 (diseased and dead). Re-survey during summer 1986 will enable us to determine rate parameters.

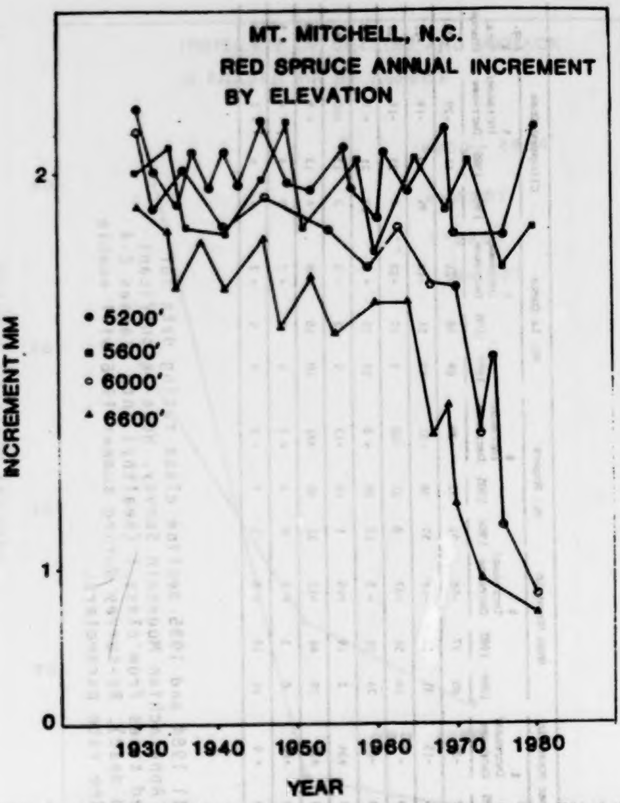


Figure 8. 1983 preliminary increment core survey of Mt. Mitchell N.C. Higher elevation trees exhibited greater ring suppression as compared to lower elevation red spruce.

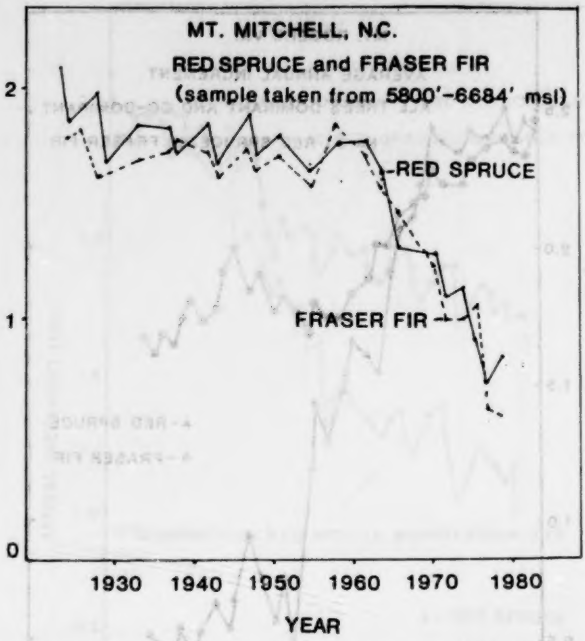


Figure 9. 1983 preliminary increment core survey of Mt. Mitchell N.C. This (biased) ridge top survey (across the Black Mountain Range) indicated synchronous ring compression beginning in the early 1960's.

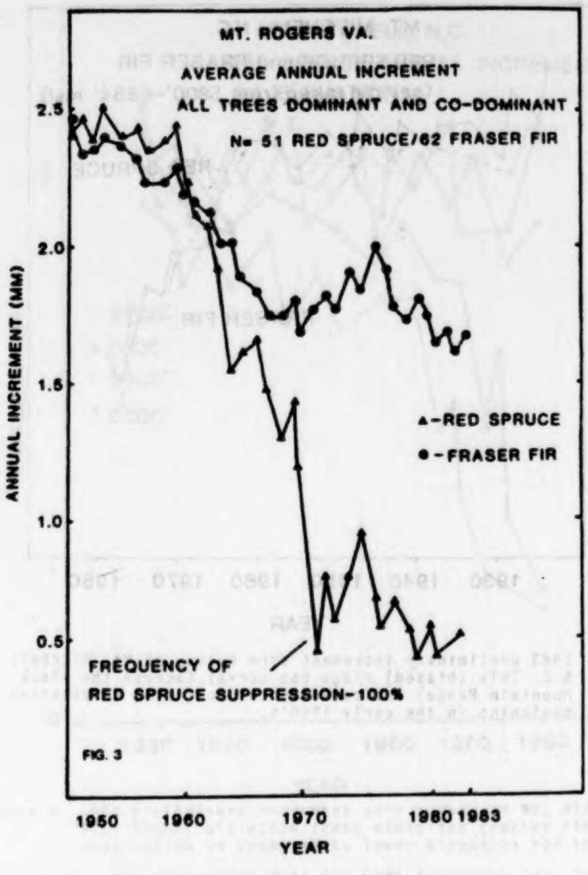


FIG. 3

Figure 10. Raw ring width data for 1984 increment core survey on EPA permanent plots for Mt. Rogers VA.

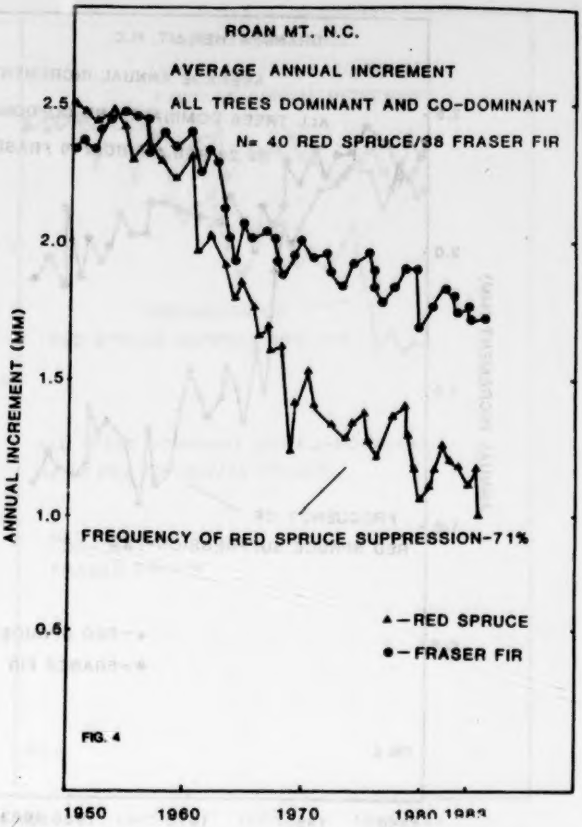


Figure 11. Raw ring width data for 1984 increment core survey on EPA plots for Roan Mt., N.C.

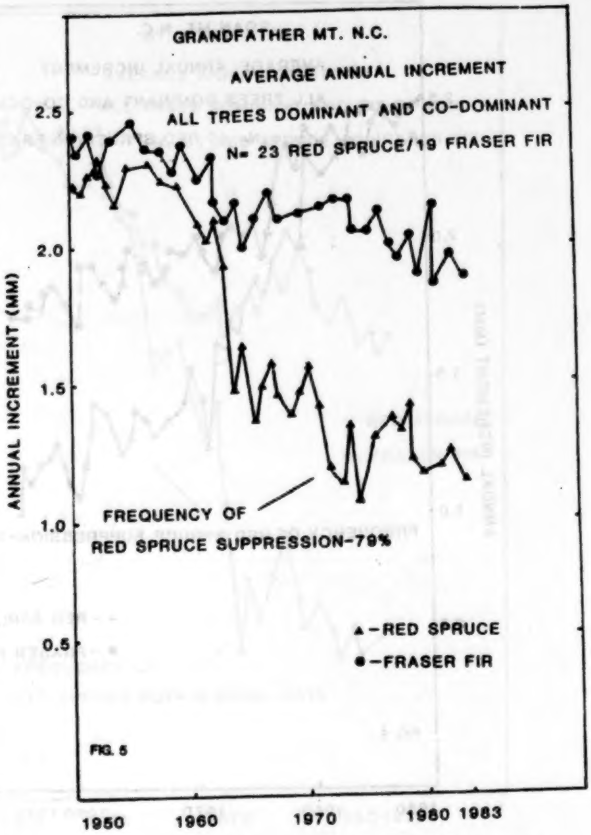


Figure 12. Raw- ring width data for 1984 increment core survey on EPA plots for Grandfather Mt., N.C.

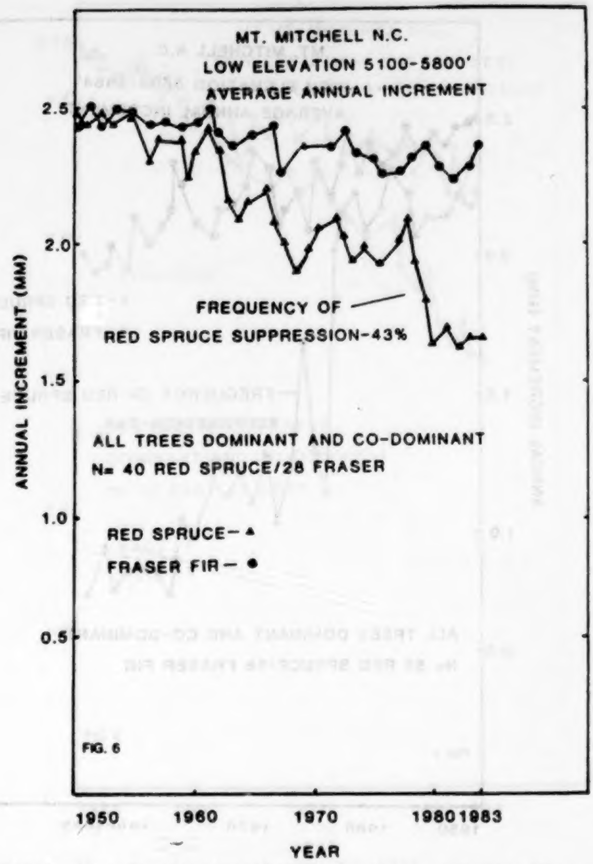


Figure 13. Raw ring-width data for 1984 increment core survey on EPA plots for low-elevation red spruce stands on Mt. Mitchell, N.C.

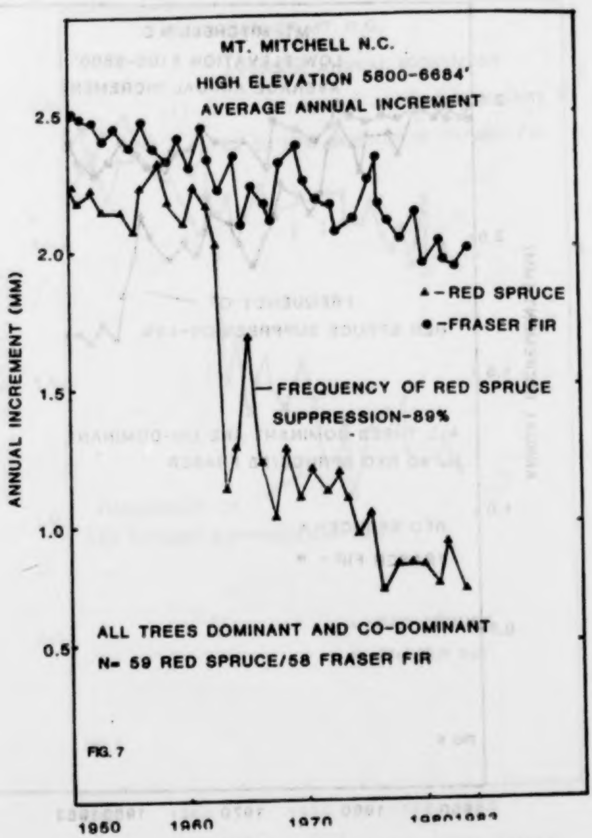


Figure 14. Raw ring-width data for 1984 increment core survey on EPA plots comparing high-elevation red spruce and Fraser fir ring compression for Mt. Mitchell, N.C.

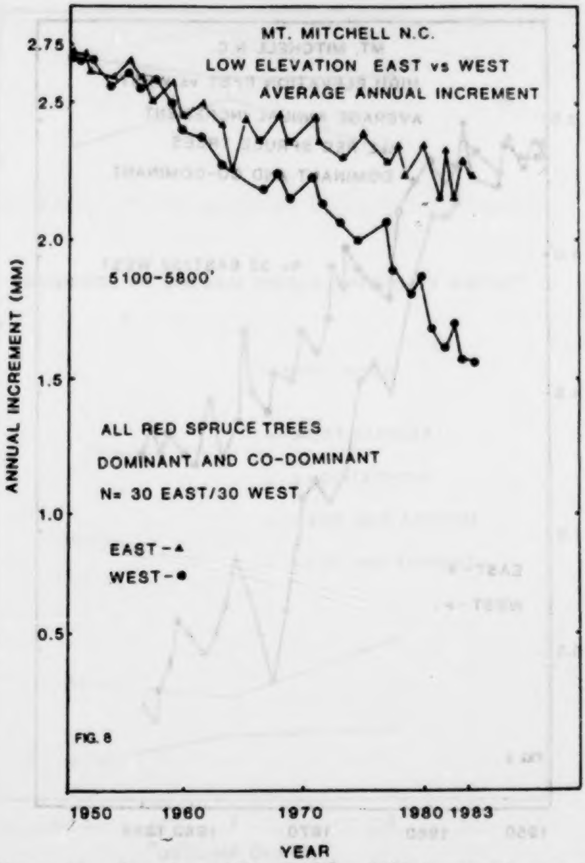


Figure 15. Raw ring-width data for 1984 increment core survey comparing red spruce at low-elevation east vs. west aspects, on Mt. Mitchell N.C.

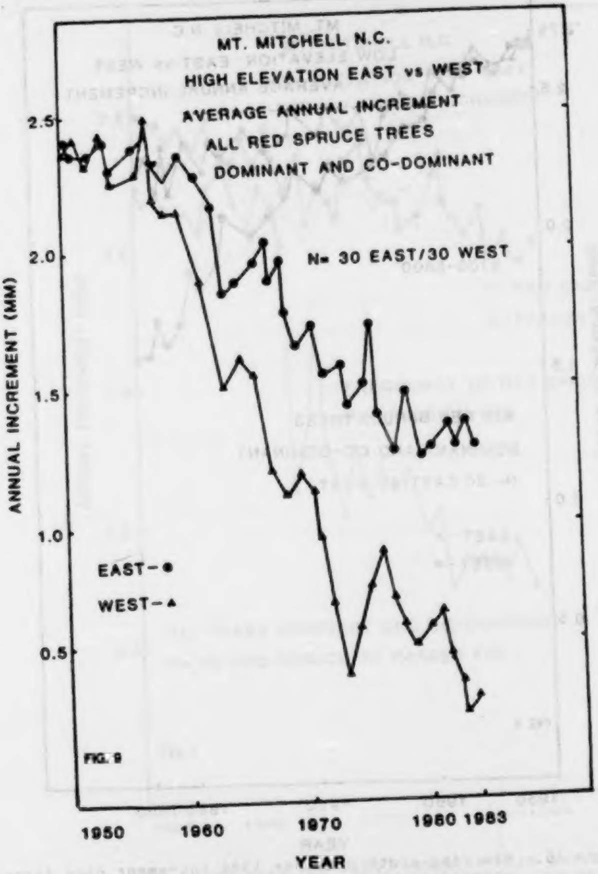


Figure 16. Raw ring-width data for 1984 increment core survey comparing red spruce at high-elevation east vs. west aspects for Mt. Mitchell, N.C.

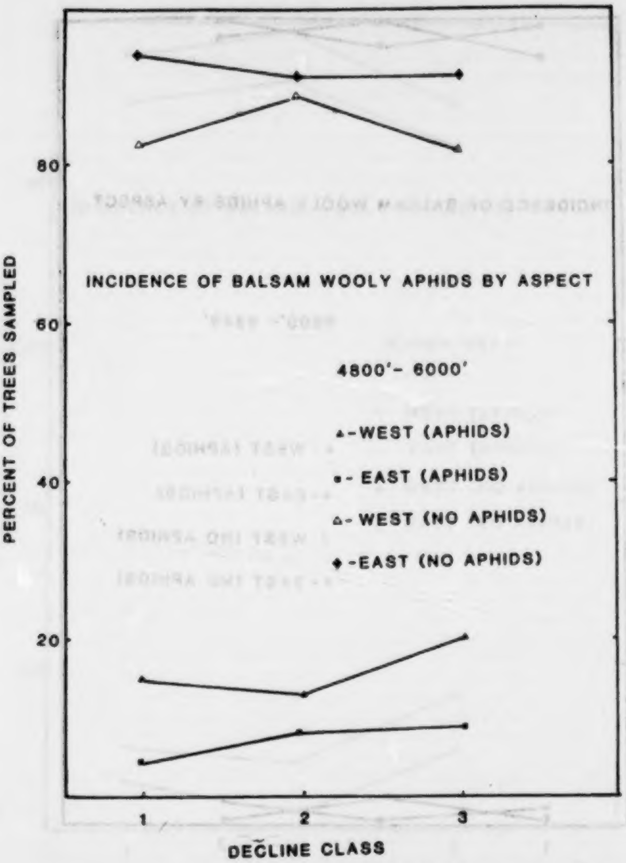


Figure 19. Incidence of Balsam Wooly Aphid on all Fraser fir from 1984 EPA survey. Aphid presence was more evident on west-facing slopes.

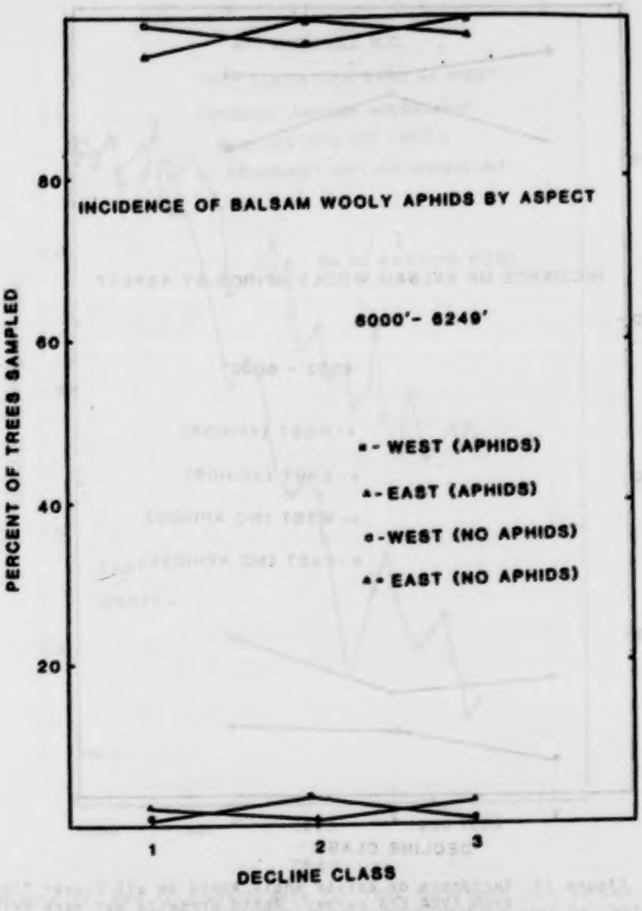


Figure 20. Incidence of Balsam Wooly Aphids on all mid-elevation Fraser fir from 1984 EPA survey. Very few signs or symptoms of aphid presence were noted.

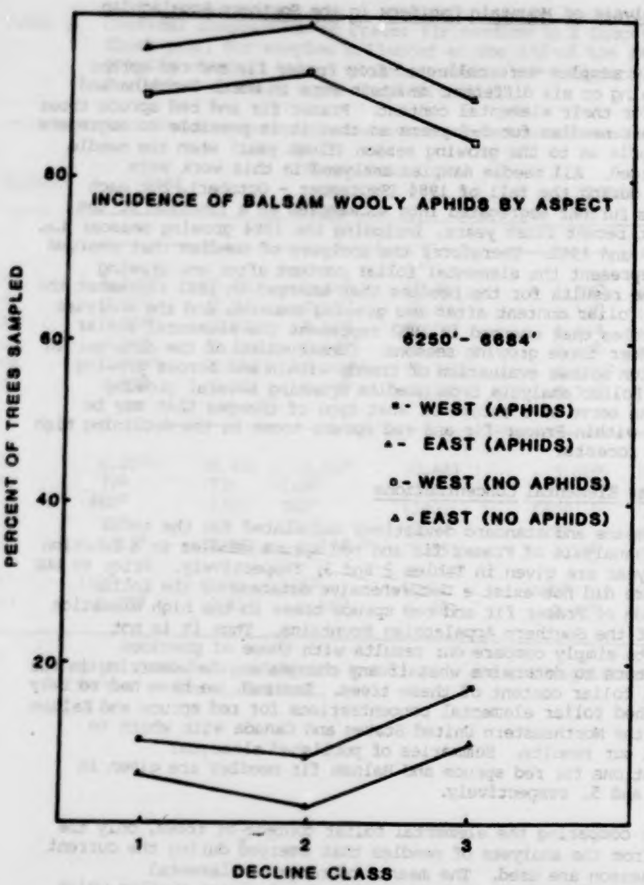


Figure 21. Incidence of Balsam Wooly Aphid on all high-elevation Fraser fir from 1984 EPA survey. Greater aphid incidence was noted here as compared to lower elevation stands/

Foliar Analysis of Mountain Conifers in the Southern Appalachian Mountains

Needle samples were collected from Fraser fir and red spruce trees growing on six different mountain tops in North Carolina and analyzed for their elemental content. Fraser fir and red spruce trees retain their needles for 5-7 years so that it is possible to segregate needle whorls as to the growing season (flush year) when the needle first emerged. All needle samples analyzed in this work were collected during the fall of 1984 (September - October), but each sample was further segregated into subsamples as a function of the three most recent flush years, including the 1984 growing season: i.e. 1984, 1983 and 1982. Therefore, the analyses of needles that emerged in 1984 represent the elemental foliar content after one growing season, the results for the needles that emerged in 1983 represent the elemental foliar content after two growing seasons, and the analyses of the needles that emerged in 1982 represent the elemental foliar content after three growing seasons. Construction of the data set in this fashion allows evaluation of trends within and across growing seasons. Foliar analysis from needles spanning several growing seasons can serve as a record of what type of changes that may be occurring within Fraser fir and red spruce trees in the declining high elevation forests.

Foliar Elemental Concentrations

The means and standard deviations calculated for the total elemental analysis of Fraser fir and red spruce needles as a function of flush year are given in Tables 2 and 3, respectively. Prior to our work, there did not exist a comprehensive database of the foliar composition of Fraser fir and red spruce trees in the high elevation forests of the Southern Appalachian Mountains. Thus it is not possible to simply compare our results with those of previous investigators to determine what if any changes may be occurring in the elemental foliar content of these trees. Instead, we have had to rely on published foliar elemental concentrations for red spruce and Balsam fir from the Northeastern United States and Canada with which to interpret our results. Summaries of published elemental concentrations for red spruce and Balsam fir needles are given in Tables 4 and 5, respectively.

When comparing the elemental foliar content of trees, only the results from the analyses of needles that emerged during the current growing season are used. The means and range of elemental concentrations observed for Fraser fir and red spruce needles which emerged during the 1984 growing season are listed with the range of published elemental concentrations in Tables 6 and 7, respectively. Comparison of the two sets of data indicate no significant nutrient deficiencies except for calcium (Ca) in red spruce. The mean

Table 2. Chemical composition of Fraser fir needles as a function of flush year, for samples collected at the end of the 1984 growing season. Values given are means (+/- standard deviation) for all trees sampled (n=41).

Element	1984		Flush Year 1983		1982	
			%			
N	1.54^{a+}	(0.16)	1.50^{a}	(1.30)	1.37^{b}	(0.13)
P	0.18^{a}	(0.03)	0.15^{b}	(0.02)	0.13^{c}	(0.02)
S	0.10^{a}	(0.02)	0.10^{a}	(0.02)	0.09^{a}	(0.01)
Ca	0.34^{a}	(0.11)	0.44^{b}	(0.11)	0.47^{b}	(0.12)
Mg	0.089^{a}	(0.018)	0.081^{b}	(0.019)	0.059^{c}	(0.015)
K	0.53^{a}	(0.10)	0.43^{b}	(0.08)	0.37^{c}	(0.06)
			mg/kg			
Cu	4.01^{a}	(0.63)	4.08^{a}	(0.48)	3.60^{b}	(0.48)
Fe	77^{a}	(23)	126^{b}	(56)	131^{b}	(51)
Mn	460^{a}	(230)	560^{a}	(240)	540^{a}	(240)
Zn	30^{a}	(8)	32^{a}	(8)	29^{a}	(8)
Co	0.13^{a}	(0.06)	0.11^{a,b}	(0.05)	0.10^{b}	(0.04)
Al	310^{a}	(140)	360^{a}	(100)	360^{a}	(120)
Pb	0.65^{a}	(0.41)	2.86^{b}	(1.28)	2.78^{b}	(1.09)

[+] Means in rows followed by the same letter are not significantly different at the 0.05 level.

Table 3.. Chemical composition of Red Spruce needles as a function of flush year, for samples collected at the end of the 1984 growing season. Values given are means (+/- standard deviation) for all trees sampled (n=30).

	Flush Year					
Element	1984		1983		1982	
	%					
N	1.05^{a+}	(0.10)	1.14^{a}	(0.13)	1.07^{b}	(0.09)
P	0.13^{a}	(0.02)	0.12^{b}	(0.02)	0.10^{c}	(0.01)
S	0.07^{a}	(0.01)	0.07^{a}	(0.01)	0.08^{a}	(0.02)
Ca	0.14^{a}	(0.03)	0.22^{b}	(0.06)	0.28^{b}	(0.07)
Mg	0.069^{a}	(0.011)	0.066^{a}	(0.015)	0.056^{b}	(0.021)
K	0.56^{a}	(0.11)	0.46^{b}	(0.09)	0.43^{c}	(0.10)
	mg/kg					
Cu	3.35^{a}	(0.49)	2.84^{b}	(0.36)	2.73^{b}	(0.42)
Fe	52^{a}	(30)	58^{a}	(29)	66^{a}	(20)
Mn	520^{a}	(190)	670^{b}	(250)	670^{b}	(220)
Zn	24^{a}	(3)	14^{a}	(4)	17^{a}	(7)
Co	0.17^{a}	(0.08)	0.17^{a}	(0.09)	0.13^{a}	(0.07)
Al	91^{a}	(36)	133^{b}	(98)	155^{b}	(52)
Pb	0.5^{a}	(0.2)	0.63^{a}	(0.41)	1.00^{b}	(0.40)

+ Means in rows followed by the same letter are not significantly different at the 0.05 level.

concentration of calcium we obtained for red spruce (1440 mg/kg) falls below the range of concentration values for calcium reported for red spruce in the Northeastern United States (1830-7900 mg/kg). In other words, over 70% of the red spruce trees sampled during our survey appear to be deficient in calcium.

Deficiencies in foliar concentrations of magnesium (Mg) and potassium (K) have been reported for spruce and fir trees in West Germany and Canada (Zoettl and Huettl, 1985; Tomlinson, 1986, 1985), but neither of these elements appears to be deficient in the Fraser fir and red spruce trees sampled during our survey. Failure to see foliar deficiencies in magnesium or potassium may be due to the presence of minerals in the soils of the Southern Appalachian Mountains which contain substantial amounts of these elements. Release of magnesium and potassium during normal weathering of these soil minerals may be sufficient to support good tree growth.

The observed deficiency in foliar calcium concentrations for red spruce may be due to a lack of plant available calcium in the surrounding forest floor and mineral soil (i.e. loss of plant available calcium due to enhanced leaching by acidic deposition), and/or to the inability of the root system of red spruce to accumulate sufficient amounts of calcium to support good growth. Failure to see a pronounced deficiency in the foliar calcium concentrations of Fraser fir suggests that the amount of plant available calcium in the surrounding soils is sufficient to support growth. The observed deficiency of calcium for red spruce, therefore, may actually only be a symptom of a causal agent or set of processes which is having a direct negative effect on the rooting system of red spruce trees in the Southern Appalachian Mountains.

For the remaining nutrient elements measured in this study (sulphur (S) and cobalt (Co)) we were unable to find published values with which to compare our results. The recommended sulphur concentration for Fraser fir grown as Christmas trees is 800 mg/kg (Dr. J. Shelton, personal communication, Table 6), which agrees well with the sulphur concentrations observed for both red spruce and Fraser fir (Tables 1 and 3). The concentrations of Co are greater in red spruce than in Fraser fir, but the actual differences between each species are relatively small.

The concentrations of aluminum (Al) in both Fraser fir and red spruce needles is greater than that listed for published values, but the actual database of published foliar aluminum concentrations in these species is very limited. Ulrich (1985) has proposed that acidification of soils from the impact of acidic deposition will result in the mobilization of toxic forms of aluminum which will in turn limit tree growth. One expression of an increase in the availability of aluminum to tree uptake would be an increase in the concentration of aluminum in needle tissue. However, this increase in

Table 4. Summary of published elemental concentrations for red spruce. Unless otherwise noted, it is assumed that all samples were from dominant or co-dominant trees.

Element										Reference
N	P	K	Ca	Mg	Cu	Fe	Mn	Zn	Al	
------	%	----	mg/kg							
.89	.1	.35	7900	2000	-	-	-	-	-	Lutz & Chandler 1947
1.11	.23	.82	2700	700	5.1	52	1493	26	19	Safford and Young 1968
1.14	.18	.88	2700	700	4.3	47	1036	31	16	samples collected from three
1.14	.19	.77	2600	700	7.1	67	861	36	24	different soil series
1.26	.1	.49	3000	600	-	-	-	-	-	Likens & Borman 1970
1.33	.135	.412	7840	-	8.9	234	1375	63	-	Stark 1973
.86	.14	.68	2100	700	3.5	25	600	24	16	Safford et al. 1977
1.15	.26	1.13	4600	1100	9	75	2650	52	47	min & max. values over 6 yrs.
.82	.16	.49	3100	700		42	1600	56		Czapowskyj et al. 1980 understory trees
-	.09	.38	4500	800	-	70	1700	-	44	Fernandez & Struchtemeyer 1984 mean of 66 trees
										Tomlinson 1985 Camel's Hump Mt., Vt.
-	-	-	1050	520	-	-	-	-	-	brown needles 1983 season
-	-	-	1830	430	-	-	-	-	-	green needles 1982 season
										Whiteface Mt., NY
-	-	-	1950	620	-	-	-	-	-	yellow needles 1984 season
-	-	-	2700	470	-	-	-	-	-	green, yellow tip 1983 season
-	-	-	3190	420	-	-	-	-	-	green, yellow tip 1982 season
										Whiteface Mt., NY
-	-	-	2910	840	-	-	-	-	-	slight yellow cast 1984 season
-	-	-	4010	730	-	-	-	-	-	" 1983 "
-	-	-	5150	630	-	-	-	-	-	" 1982 "
-	-	-	5100	430	-	-	-	-	-	" 1981 "

Table 5 Summary of published elemental concentrations for Balsam fir. Unless otherwise noted, it is assumed that all samples were from dominant or co-dominant trees.

Element										Reference
N	P	K	Ca	Mg	Cu	Fe	Mn	Zn	Al	
------	%	-----	-----------------	-----	mg/kg	-----	-----	-----	-----------------	
1.96	.187	.662	6610	1200	10.9	294	1125	35	-	Stark 1973
-	-	-	-	-	3.55	-	-	-	-	Stone & Timmer 1975
1.23	.19	.48	5700	1000	-	-	-	-	-	Timmer & Stone 1978
1.25	.19	.48	7700	1200	-	-	-	-	-	Morrison & Foster 1979
.95	.19	.61	5100	800	-	35	1600	48	-	Czapowskyj et al. 1980
1.26	.18	.62	4600	1300	-	-	-	-	-	Krause et al. 1982
1.18	.19	.62	4500	1200	-	-	-	-	-	samples collected at
1.15	.19	.64	4200	1300	-	-	-	-	-	different locations
1.19	.20	.64	3800	1300	-	-	-	-	-	in Quebec, Canada
1.13	.17	.57	4400	1200	-	-	-	-	-	"
1.21	.18	.65	4900	1500	-	-	-	-	-	"
1.19	.17	.59	3400	1200	-	-	-	-	-	"
1.56	.14	.48	4500	1400	-	-	-	-	-	"
1.51	.19	.67	5500	1900	-	-	-	-	-	"
1.28	.16	.48	5300	1400	-	-	-	-	-	"
1.34	.12	.42	4700	1000	-	-	-	-	-	"
1.44	.14	.52	5000	1200	-	-	-	-	-	"
1.15	.12	.53	5600	1100	-	-	-	-	-	"
2.48	.18	.65	1210	390	-	-	-	-	-	Lang et al. 1982 current year's needles
2.41	.13	.49	2110	300	-	-	-	-	-	3 year old needles
2.26	.10	.38	2570	260	-	-	-	-	-	>3 year old needles
-	-	-	3870	760	-	-	-	-	-	Tomlinson 1985 Whiteface Mt., NY green needles 1984 season
-	-	-	5260	330	-	-	-	-	-	yellow needles 1983 season
-	-	-	6070	370	-	-	-	-	-	yellow needles 1982 season
-	-	.90	3840	1030	-	-	-	-	-	Newcombe, NY green needles 1984 season
-	-	.74	6720	1130	-	-	-	-	-	yellow needles 1983 season
-	-	.53	8130	980	-	-	-	-	-	yellow needles 1982 season

Table 6. Means and range of concentrations observed for N, P, K, Ca, Mg, Cu, Fe, Mn, Zn and Al (1984 growing season) for Fraser fir compared to published values for Balsam fir (Table 5), and recommended values for Christmas Tree (Fraser fir) growers in Western North Carolina.

	Year: 1984			Published values		Recommended values
	mean	range		range		
		min	max	min	max	
	%			%		%
N	1.54	1.31	2.02	.95	2.48	1.75a
P	.18	.13	.27	.12	.20	.20
K	.54	.21	.74	.42	.90	.60
	mg/kg			mg/kg		mg/kg
Ca	3350	1700	6740	1200	7700	6000
Mg	890	530	1410	390	1800	1250
Cu	4.0	2.6	5.3	3.6	10.9	5.5
Fe	77	42	131	35	294	55
Mn	460	124	1300	1130	1600	75
Zn	30	17	52	35	48	25
Al	307	144	977	-	-	-

a. Source: Dr. J. Shelton, Department of Soil Science, NCSU, Mountain Research Laboratory, Fletcher, NC. 28732.

Table 7. Means and range of concentrations observed for N, P, K, Ca, Mg, Cu, Fe, Mn, Zn and Al (1984 growing season) for red spruce compared to published values (Table 1).

	Year: 1984			Published values	
	mean	range		range	
		min	max	min	max
	%			%	
N	1.05	.87	1.28	.82	1.33
P	.13	.1	.18	.09	.26
K	.57	.37	.84	.35	1.13
	mg/kg			mg/kg	
Ca	1440	846	2280	1830	7900
Mg	690	480	960	430	2000
Cu	3.4	2.4	4.5	3.5	9
Fe	52	32	202	25	234
Mn	520	240	990	600	2650
Zn	14	10	20	24	63
Al	91	25	225	16	47

aluminum concentration is usually accompanied by a decrease in the concentration of nutrients. Such a decrease in the concentration of nutrients in the needle tissue of Fraser fir does not appear to be happening even though Fraser fir has substantially higher amounts of aluminum in its needle tissue than red spruce. One explanation for this is that Fraser fir is more adaptive at handling toxic concentrations of aluminum than red spruce, but it is also possible that the concentrations of aluminum observed in the needle tissue of both species is the natural result of the adaptation of these trees to their environment. Soils of the red spruce-Fraser fir ecosystem are typically acidic and in evolving to survive in this ecosystem, red spruce and Fraser fir trees have had to adept to the presence of potentially toxic concentrations of aluminum in their rooting zone. Thus the differences in foliar aluminum concentration between these two species may be an expression of their ability to adapt to the presence of toxic elements such as aluminum and to actually cycle these elements along with other nutrient elements through the ecosystem.

Foliar Elemental Concentrations as a Function of Flush Year

Nutrient elements in trees can be grouped into two classes: mobile and immobile. Those elements considered immobile (e.g. calcium) accumulate within plant tissue. Thus, the longer a needle remains on a tree, the higher the concentration of immobile elements in its tissue. An example of this is given in Figures 22 and 23 for the concentration of calcium in red spruce and Fraser fir needles as a function of flush year. Mobile elements, such as phosphorus (P), are transferred from older needles to younger needles by trees. Thus, the concentration of phosphorus decreases in needle tissue the longer a needle remains on a tree (Figures 24 and 25). Having the ability to reallocate resources within its needles gives the trees an advantage in adapting to soils where available nutrients may limit tree growth. Failure to observe a decrease in the concentration of a mobile element such as phosphorus from older needles to younger needles indicates that the supply of that element is not limiting to growth or that the tree is actively being fertilized with that particular nutrient.

Comparison of foliar elemental concentrations as a function of flush year indicated no significant deviations in the patterns expected for known mobile and immobile elements in plants, except for nitrogen (N) in red spruce. Nitrogen is considered a mobile element and should decrease in concentration in older needles. The concentration of nitrogen in Fraser fir needles was observed to decrease as a function of flush year (Figure 26), but not in red spruce needles (Figure 27). In fact, the concentration of nitrogen is essentially constant in the three flush years sampled. The lack of a decrease in nitrogen concentration with age of the needles on red spruce, therefore, is probably due to an increase in the availability of nitrogen, either in the surrounding soil or by foliar uptake of

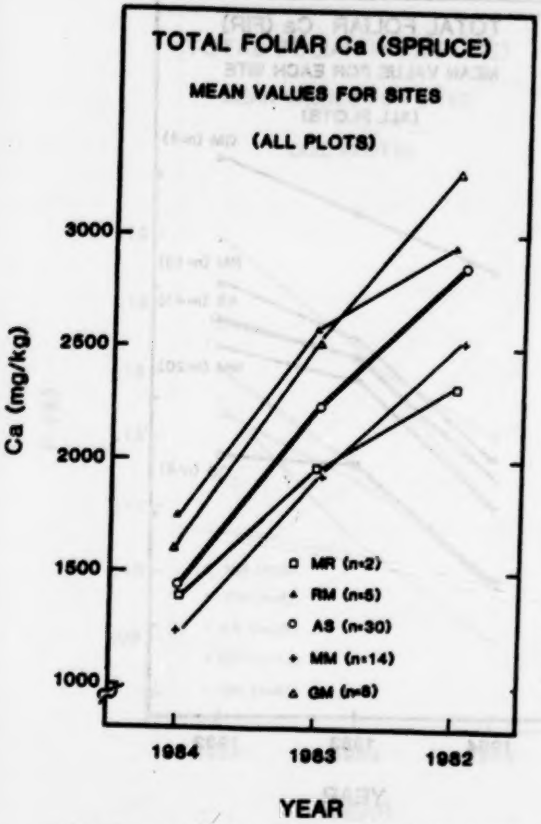


Figure 22. Mean total Ca (Spruce) for red spruce as a function of flush year for all sites combined (AS) and for each mountain location sampled (GM-Grandfather Mt., NC; RM-Roan Mt., NC; MM-Mt. Mitchell, NC; MR-Mount Rogers, VA).

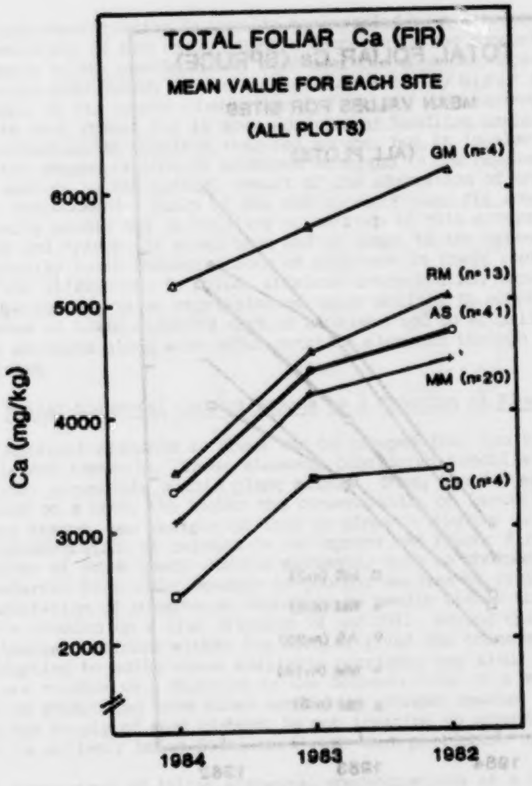


Figure 23. Mean total Ca (Fir) for Fraser fir as a function of flush year for all sites combined (AS) and for mountain location sampled (GM-Grandfather Mt., NC; RM-Roan Mt., NC; MM-Mt. Mitchell, NC; CD-Clingman's Dome, GSMNP).

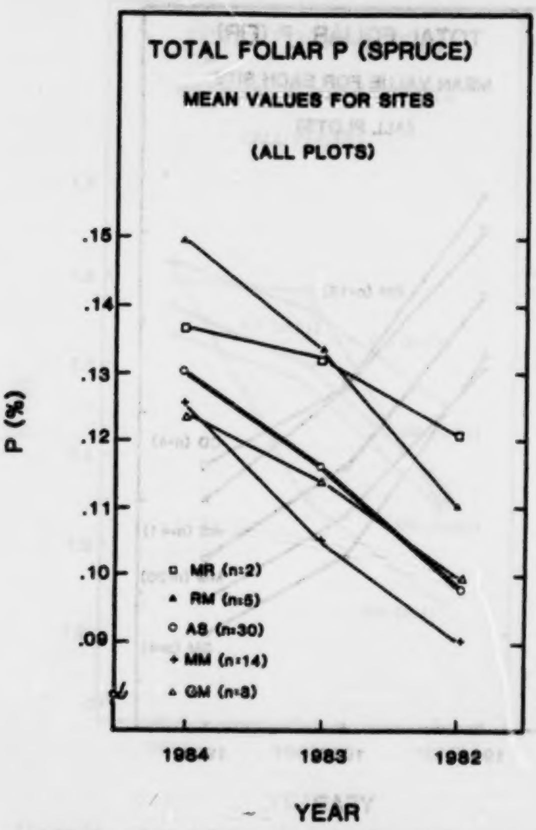


Figure 24. Mean total P (Spruce) for red spruce as a function of flush year for all sites combined (AS) and for each mountain location sampled (GM-Grandfather Mt., NC; RM-Roan Mt., NC; MM-Mt. Mitchell, NC; MR-Mount Rogers, VA).

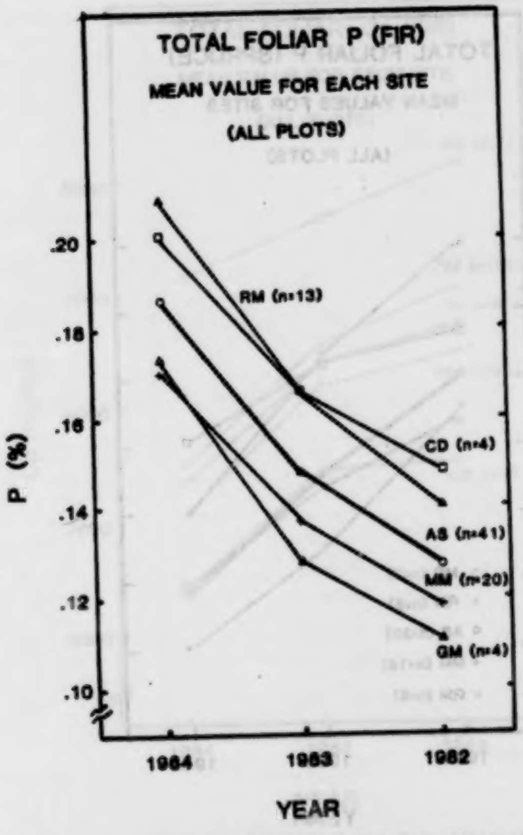


Figure 25. Mean total P (Fir) for Fraser fir as a function of flush year for all sites combined (AS) and for mountain location sampled (GM-Grandfather Mt., NC; RM-Roan Mt., NC; MM-Mt. Mitchell, NC; CD-Clingman's Dome, GSMNP).

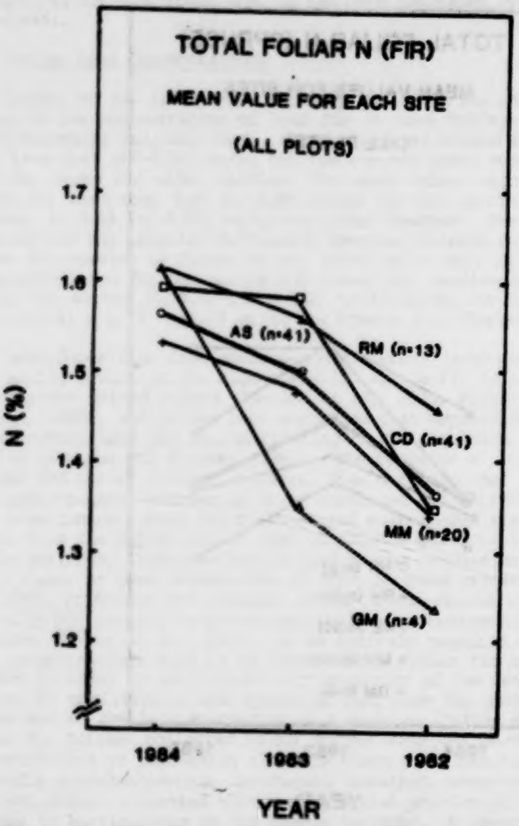


Figure 26. Mean total N (Fir) for Fraser fir as a function of flush year for all sites combined (AS) and for mountain location sampled (GM-Grandfather Mt., NC; RM-Roan Mt., NC; MM-Mt. Mitchell, NC; CD-Clingman's Dome, GSMNP).

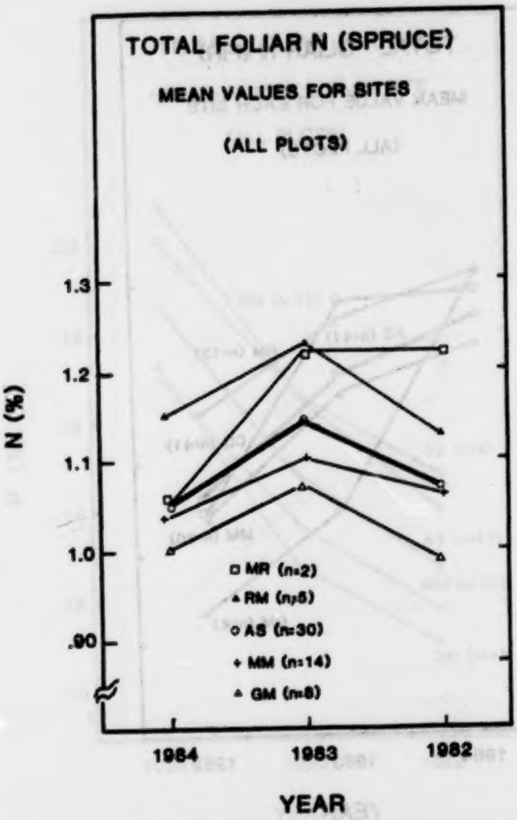


Figure 27. Mean total N (Spruce) for red spruce as a function of flush year for all sites combined (AS) and for each mountain location sampled (GM-Grandfather Mt., NC; RM-Roan Mt., NC; MM-Mt. Mitchell, NC; MR-Mount Rogers, VA).

atmospheric nitrogen compounds, as has been suggested by Friedland et al. (1985).

Foliar Lead Concentrations

Turner et al. (1985) have recently published the results of a survey of the concentration of lead (Pb) in tree foliage in the Great Smoky Mountains National Park. Mean values calculated for red spruce were from 0.65 (+/-0.18) mg/kg for the current years needles, to 0.95 (+/-0.42) mg/kg for older needles. The mean values calculated for Fraser fir were from 0.64 (+/-0.46) mg/kg for the current years needles, to 2.69 (+/-2.02) mg/kg for older needles. The actual values measured and the relative difference observed between red spruce and Fraser fir needles by Turner et al. (1985) agree very well with the means calculated for red spruce and Fraser fir needles collected during our survey (0.50 +/-0.2 - 1.00 +/-0.4 mg/kg for red spruce and 0.65 +/-0.41 - 2.78 +/-1.09 mg/kg for Fraser fir; Tables 3 and 2).

Lead deposition from anthropogenic sources is known to occur at substantial levels in the high elevation spruce-fir forests of the Northeastern United States (Johnson et al., 1983; Friedland and Johnson, 1985), and it has been suggested that deposition of anthropogenic lead may be contributing to the phenomena of forest decline (Johnson and Siccama, 1983). The presence of lead in Fraser fir and red spruce foliage, however, does not mean that lead deposited from anthropogenic sources is being mobilized and actively accumulated into tree tissue. Lead found associated with needle tissue can be either from the deposition of lead containing particulates onto the needle surfaces, translocation of lead to the needles as a result of root uptake, or some combination of both of these processes (Turner et al., 1985; Friedland and Johnson, 1985). Since needle samples are typically NOT treated to remove particulate contaminants from their surfaces (Turner et al., 1985), it is entirely possible that foliar lead concentrations such as we observed for Fraser fir and red spruce are due strictly to particulate contamination of the needle surfaces and not to mobilization and uptake of lead from the surrounding soil. Comparison of the lead concentrations measured for red spruce and Fraser fir foliage collected in our survey with the measured concentrations of rare-earth elements known to be associated with dust on needle surfaces (cerium, lanthanum, scandium, samarium and thorium, data not shown) suggested that a substantial portion of the lead found was due to particulates on the needle surfaces. However, lack of a suitable cleaning agent that will completely remove surface particulates and not compromise the integrity of needle samples prevents any final conclusions regarding lead concentrations observed for red spruce and Fraser fir needles collected in the field. Although lead is known to be toxic to plant growth, little data is currently available to substantiate whether lead or other toxic metals from anthropogenic sources is influencing tree growth in the spruce-fir ecosystem.

Soils of the High Elevation Spruce-Fir Forests of the Southern Appalachian Mountains

Soils of the high elevation spruce-fir forests are often thought of as being shallow (<1 meter in depth), with thick organic mats from accumulation of leaf litter overlying coarse grained mineral soil. Such a description applies well to the high elevation spruce-fir forests of the Northeastern United States, where the cooler temperatures favor accumulation of organic matter, and glacial activity has resulted in an impervious glacial till horizon 1-1.5 meters below the soil surface. Such a description, however, is not appropriate for the soils of the high elevation spruce-fir forests of the Southern Appalachian Mountains.

Warmer temperatures, lack of glacial activity and differences in the geology of the Southern Appalachian Mountains combine to form soils which are substantially different than those in the Northeastern United States. Total soil depth varies considerably depending upon landscape position. Shallow soils dominant along ridge tops, where depth to bedrock is often less than 1 meter, but such areas comprise only a small fraction of the total landscape. Typically, soil depths exceed 1 meter and often two meters on side slopes and within draws. Numerous large buried rocks give the impression of shallowness to the casual observer, but excavation reveals that soil development has continued further down beyond the rocky layers.

The presence of relatively deep soils and an underlying zone of extensively weathered rock is an indication of the degree of water movement in these soils and the influence of a warmer climate. Lack of a pronounced, readily identifiable organic mat on the surfaces of these soils is also a reflection of the warmer climate. Decomposition by soil microorganisms, and mixing with the underlying mineral soil by soil fauna is extensive, indicating that additions to the forest floor, either from the ecosystem itself, or from outside sources such as atmospheric deposition, are quickly incorporated into the dynamics of the ecosystem. Other agents of mechanical disturbance are also evident, including wind throw with subsequent uplifting of the surface layers of soil with the root system, erosion and slumping (movement of large masses of soil and rock down slope in response to the steepness of the gradients). It has been estimated that such activities may completely rework the entire surface of these soils every one hundred years.

Such activities within the soils of the Southern Appalachian Mountains results in considerable variability in the composition of the upper soil horizons, both locally and as a function of elevation. This variability is in turn reflected in the chemical analysis of these soils. Results of chemical analyses are often expressed on a weight basis, for example milligrams of lead per kilogram of soil.

For agricultural soils, which are regularly mixed by tillage implements, the composition of the soil is essentially uniform. For soils in a forested ecosystem, however, the soils are mixed on a random basis and a kilogram of soil from one location may not have the same distribution of mineral and organic matter as a kilogram of soil from another location. Since soil mineral and organic matter differ substantially in composition and ability to retain nutrients, differences in the concentration of various elements are observed simply because of the heterogenity of the soil sample. This is turn makes attempting to determine differences in deposition of elements, such as lead from atmospheric processes, among locations and along elevation gradients very difficult. The natural soil variability also confounds attempts to determine what influence acidic deposition may be having on these soils. Studies designed to determine the impact of acidic deposition on the high elevation soils of the Southern Appalachian Mountains must take into account the natural variability of the soil.

Soils of the high elevation spruce-fir forests of the Southern Appalachian Mountains are similar to the high elevation forests of the Northeast in that the soils are acid (pH's of 3.3-4.7) and contain substantial amounts of potentially toxic metals such as aluminum, and lead from anthropogenic sources, in the forest floor. However, lead is also present in the underlying mineral soil because of the lead content of the original rock from which the mineral soil was derived. Lack of clear separation between the forest floor and underlying mineral soil leads to an overestimation of the amount of lead deposited by atmospheric processes by simply summing the total mass of lead found over a fixed depth increment. Such estimates must be corrected for the contribution of native lead present in the soil.

Two naturally occurring radioisotopes, cesium-137 and lead-210, both deposited by atmospheric processes, were used in our survey to provide a measure of the extent of incorporation of lead from anthropogenic sources into the soil profile. A correction factor was then applied for the lead extracted from the mineral matrix of the surface soil samples. Using this approach, we estimate total lead deposition of between 600-1300 milligrams per square meter for the spruce-fir forests in the Southern Appalachian Mountains. This estimate is only 40-50% of that reported for the spruce-fir forests of the Northeastern United States (1800-2000 milligrams per square meter) (Friedland and Johnson, 1985). However, further work is needed to generate the necessary database in order to determine whether the deposition of lead in the mountains of the Southern United States is in fact less than that in the northeast.

Prior to our survey, there were few studies designed to assess the status of soils across the entire high elevation spruce-fir forests of the Southern Appalachian Mountains. Our work indicates that these soils are substantially different from those occurring under the spruce-fir forests of the northeast. The soils are acid and contain labile sources of aluminum, but direct comparison to the soils of the northeast should be approached with caution. The variability of these soils across the landscape, and the extensive mixing of soil mineral and organic matter, will confound efforts to properly characterize the current state of these soils. Experimental designs and analytical procedures used to characterize soils in the northeast should be used with caution, or may be totally unsuitable for use in the southern spruce-fir ecosystem.

The presence of primary minerals which can release plant nutrients in the rooting zone of these soils suggests that these soils may have the ability to rapidly replenish nutrients lost as a result of leaching by acidic deposition. The depth of weathering in these soils has also resulted in the formation of secondary minerals which are known to absorb sulfate anions. Thus, these soils may be acting as effective buffers of acidic deposition for the surrounding watersheds. However, the current state of knowledge of the chemical processes occurring within the soils of the high elevation spruce-fir forest of the Southern United States is minimal, and further work is needed to properly predict how these soils will respond to continued inputs of acidic deposition.

Studies Concerning the Incidence of Forest Decline on Three Continents

For the past 3-years Dr. Robert I. Bruck has undertaken as a research objective - to visit high altitude spruce-fir ecosystems throughout North America, Europe and Asia to determine whether or not there is a consistant incidence of forest decline in those areas. Beginning in 1983 permanent observation plots were established in the Black Forest of W. Germany, the southern Appalachian Mountains, the Mount Hood area of Oregon's Cascade Mountains, the Gothic Mountain-Gunnison area of the Colorado Rocky Mountains, the Alaska Range surrounding Mt. McKinley in Alaska and the Mt. Everest Solu-Khumbu region of the Himalayas of Asia. High elevation boreal montane conifer stands were selected in each one of these regions to represent a "typical" western facing aspect for each respective sampling site. Upon plot establishment using techniques similar to the southern Appalachian mountain survey dominant and co-dominant trees were rated for their physical condition or appearance and increment cores selected from certain individuals for dendrochronological analysis. In addition surface soil samples 0-3 centimeters were collected using a mass per unit area measurement for the determination of nutrients and toxic metals.

Figure 28 illustrates a summary of the average percent of symptomatic trees e.g. those trees exhibiting more than 11% visible defoliation from the six regions that were explored. Through the assistance of colleagues studying the forest decline (Waldsterben) syndrome in West Germany it was determined that approximately 49% of trees in the area of the Black Forest of West Germany exhibited some symptoms of Waldsterben indicating that these fell into the greater than 11% defoliation category. Studies conducted by the two authors of this testimony in the southern Appalachian mountains have indicated that on west facing slopes approximately 38% of all trees scored are categorized as being in the decline category of greater than 11% defoliation. Quite contrary to the observations made in both the southeastern United States and West Germany, observations from the Cascades of Oregon, the Rocky Mountains of Colorado, the Alaska range of Alaska, and the Mt. Everest region of the Himalayas indicated that between 2 and 9% of all trees exhibited visual decline symptoms. It must be remembered that these decline symptoms include stress from all biotic diseases and insects present on these sites. We would expect that from the natural endemic or background levels of pest and pathogens in the environment that there would be between 5 and 10% stressed individuals exhibited on all sites. The relative health of particularly the Himalayan forests was unusual to observe.

Figure 29 illustrates the average 5 year combined annual radial increment measurements of growth from trees from the same regions as previously described in the forest decline symptomatology Figure 1. The only exception is that relatively high elevation trees (above

1,500 meters) from the Calcarius Alps of southern Germany were used for increment core analysis. It is interesting to note that for the areas of West Germany and the Southern Appalachian mountains during the period of 1955 to 1960 an abrupt decrease (shift to lower annual radial increments) was observed. The annual increments observed in this preliminary survey of all other sites illustrate a continuous normal growth pattern. In fact for the sites in Alaska, the Rocky Mountains, and the Himalayas there appears to be a slight however not statistically significant increase in the annual growth increments from approximately 1960 to the present time. Some investigators have speculated that increased enrichment of transglobal carbon dioxide may account for differences in vegetative adaptation and growth patterns particularly as ramified in pristine non-polluted regions.

Figure 30 illustrates surface soil lead accumulation in the 0-3 centimeters strata of soils collected from all six test sites. Lead was used as an indicator of surface soil organic horizon toxic metal accumulation because it is usually firmly bound within the organic matrix and hence is not very mobile. High loadings of lead were observed usually above 400 milligrams per kilogram in many areas of the Alps of West Germany. High readings for certain areas of the southern Appalachian mountains were consistantly above 200 milligrams per kilogram in these organic horizons. Again, it was interesting to note that the Cascades were accumulating usually less than 50 milligrams per kilogram, the Rocky mountains less than 25 milligrams per kilogram, the areas of the Alaska range accumulated less than 10 milligrams per kilogram, while in the Himalayas surface organic horizon lead was barely detectable. The purpose of Figure 30 is not to illustrate the accumulation of highly phytotoxic metals, as information dealing with the phytotoxicity of most heavy metals is not available at this time; but rather to illustrate that areas in which large amounts of heavy metals are accumulating probably are indicative of areas in which high anthropogenic pollution deposition is generally occurring. Therefore surface soil heavy metal contamination particularly down wind of major point source polluters are generally good indicators of total atmospheric deposition fluxes taking place within the region.

Many scientists have speculated that the reason for high altitude accumulation of anthropogenic pollutants may be attributed to direct cloud impaction on these mountain sites. Data from the Calcarius Alps indicate that cloud impaction takes place approximately 70-100 days per year. Data from the southern Appalachian mountains indicates that cloud impaction is a common event generally taking place more than 250 days per year while the Cascades of Oregon are also often bathed in clouds in excess of 200 days per year. Cloud interception data for the Rocky Mountains indicate that events in excess of 80 days per year are common however, no data is available at this writing for the Alaska range or the Mt. Everest region of the Himalayas. Atmospheric chemists have indicated that pollutants contained in cloud moisture may be the single most important contributor to montane ecosystem pollutant deposition.

The three figures just presented are not meant to form a data base that will yield conclusive evidence that anthropogenic pollution is or is not involved in forest decline syndromes, however, it is most interesting to note that in areas where known heavy anthropogenic deposition takes place trees are in fact statistically more symptomatic than trees from non-polluted areas, trees from polluted areas are in fact significantly more suppressed in terms of their growth rates over the past 25-30 years as compared to non-pollutant sites and surface soils have in fact accumulated lead, often an order of magnitude above that of non-polluted region soils. These data do not prove cause and effect relationships but rather formulate a broad correlative base in which we can compare some major silvicultural and physical characteristics of these high altitude northern hemisphere forests. Although this preliminary survey is severely limited in both its scope and depth, particularly with respect to drawing conclusions about anthropogenic deposition, it does serve as a valuable set of data to make some preliminary comparisons among and between similar types of ecosystems found throughout the world. It is also important to emphasize that air pollution comes in many and varied forms. Wet deposition of acids, toxic and nutrient elements and compounds, dry deposition of gases and aerosols, and gaseous deposition of various hydrocarbons gases and other toxic and nutrient compounds form an atmospheric "vegetable soup" particularly in industrialized areas of the world. It is not appropriate at this time to point fingers at specific pollutants and their potential interactions with the above data because information is not available to prove or even establish general cause and effect hypotheses at this time.

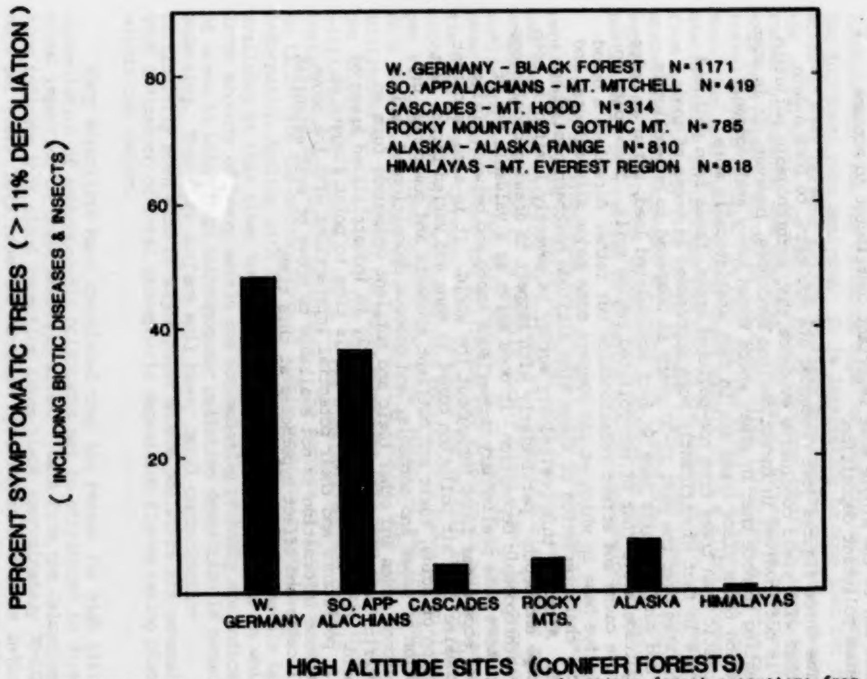


Figure 28 Percent of symptomatic trees observed in boreal montane forest ecosystems from six regions on 3 continents. Trees exhibiting significant defoliation were more common in central Europe and eastern North America.

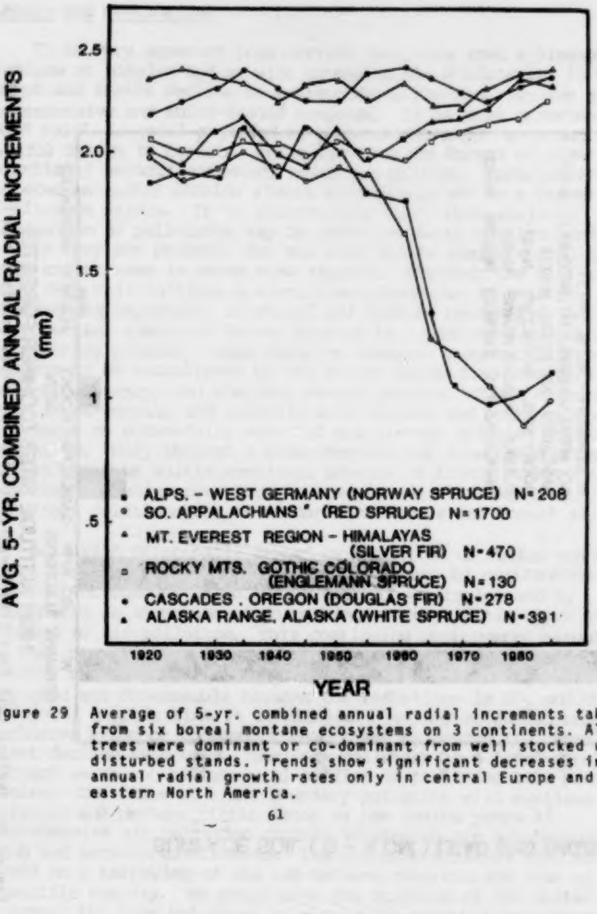


Figure 29 Average of 5-yr. combined annual radial increments taken from six boreal montane ecosystems on 3 continents. All trees were dominant or co-dominant from well stocked undisturbed stands. Trends show significant decreases in annual radial growth rates only in central Europe and eastern North America.

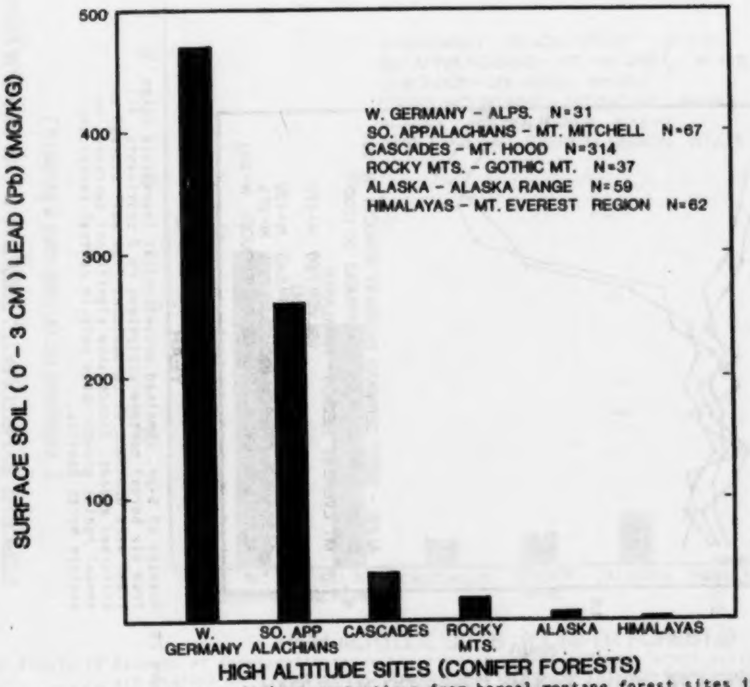


Figure 30 Surface soil lead (Pb) concentrations from boreal montane forest sites in six regions on 3 continents. Significant accumulations are observed only in central Europe and eastern North American sites. High surface soil heavy metal accumulation is probably indicative of overall high anthropogenic pollutant loading.

Summary and Conclusions

It is very apparent from current data sets that a disease syndrome as complex and as wide spread as the Waldsterben in Central Europe and forest decline in eastern North America requires a comprehensive and multi-staged response. It is most unfortunate that "acid rain", is still regarded by many as the major component of harmful damage to forests, while ignoring the dozens of other potentially harmful compounds which are present. Control efforts have centered on sulfur dioxide almost exclusively and to a lesser extent on nitrogen oxides. It is increasingly clear that whatever combination of pollutants may be affecting North American and European forests they are probably not the same agents that are acidifying lakes and streams in those same regions. Although the bill at hand today that will initiate a significant reduction in both SO_2 and NOx emissions is important, it should and must be recognized that battling the potential agents of forest decline is a much more complicated and far reaching process. Comprehensive research programs have been and continue to be established by the United States Environmental Protection Agency, and the USDA Forest Service. These efforts are meant to categorize and quantify both natural and anthropogenic influences on potentially affected and already affected forest ecosystems. Only through a comprehensive and integrated program dealing with the multidimensional aspects of forest ecosystem perturbation can we ever hope to come up with a foundation for cause and effect relationships of airborne chemicals and forest stress.

Acid rain principally caused by emissions of sulfur and nitrogen oxides has been used as the "catch all" phrase by environmentalists pressing for changes in pollution control strategies and by governments as an excuse to do nothing or very little about the broad problems of air pollution. This continuing controversy camouflages the real picture i.e. that pollution has multiple causes and multiple effects, acidification being just one of them. Although there are many good and defenseable reasons for reductions in SO_2 and NO_x emissions, at this time it is difficult for any scientist to show conclusive evidence to support that these emissions are causal in the forest decline syndromes. The "one pollutant at a time" regulatory approach we do not believe will suffice in tackleing this particular problem. The issue of trans-boundary pollution will continue to be a difficult and perhaps bitter issue in the coming years if comprehensive air pollution control strategies are not formulated among and between governments. The ultimate solution will most likely depend on a narrowing of the gap between rhetoric and that of scientific reality. We would urge the Congress of the United States to invest its time and money in sound environmental management plans and on balancing short term interests against long term environmental policies. We all realize that the cost that may be related in controlling pollution in a broad spectrum way are high. The costs of not doing so could well be more than we can all afford as a society.

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Mr. WAXMAN. Thank you, Dr. Bruck. The rest of your statement is going to be in the record.

Mr. Emler.

STATEMENT OF PAUL EMLER, JR.

Mr. EMLER. Thank you, Mr. Chairman. Good afternoon. I am Paul Emler, Jr., director of field operations for Living Lakes, Inc., Living Lakes, Inc., a not-for-profit organization, was established in January 1986 to design and implement an applied fisheries management field demonstration program for waters acidified by causes other than point source discharges, acid mine drainage or naturally acidic aquatic conditions.

It is currently funded by individual electric utility and coal companies with possible future participation by other industries and organizations. It has a board of directors comprised of chief executive officers from participating organizations and an operating committee consisting of senior executives from participating organizations including the Sport Fishing Institute.

The executive director, Dr. Robert Brocksen, has responsibilities for development and implementation of the lake and stream treatment program and corporate administration. A scientific advisory panel composed of international experts including fishing and environmental representatives has been established to assist in program design, review of continuing technical and operational activities and the technical and scientific validity of the program.

The overall objective of the Living Lakes program is to demonstrate that cost-effective management techniques are available to restore acidified and acid-stressed aquatic ecosystems.

Specific objectives include mitigative liming for the chemical neutralization of acidic aquatic systems, protective liming for the chemical neutralization of acid sensitive systems in order to protect ecologically important fisheries populations and research which will be initiated to enhance the effectiveness of applicability of future liming operations.

We at Living Lakes have presented our program to individuals in the Federal Government, State governments, and industry and environmental organizations to inform them of who we are and what our objectives are.

Contacts have also been made with various State officials for permission and cooperation to conduct our program in their respective States. We plan for 1986 the treatment of up to 30 lake sites, the stocking of fish in these sites if necessary, the implementation of posttreatment monitoring, the analysis of data and report preparation and the identification and characterization of sites for treatment in 1987 and beyond by conducting base line water quality surveys and base line fish surveys.

Thus far, nine lakes in Massachusetts have been approved for treatment in 1986 and the permitting process for six additional Massachusetts lakes has been initiated.

Our program is designed as a multicomponent program and encompasses site characterization and selection, dose estimation, application technique determination, system treatment, fish stocking, lake reapplication if needed, system monitoring and stream treatment adjustment.

A field operations implementation plan has been developed and will be finalized this month. It defines and directs how to implement the major components of the program. These components are site selection, site authorization, lake sampling, stream sampling, fish sampling, laboratory analysis, liming application, fish management, data management and analysis, quality assurance/quality control, and communication and technology transfer.

The purpose of stocking fish in treated sites is to restore and maintain fisheries that have a economic, recreational or ecological importance. The success of our program will be measured by the successful restoration of fisheries in these treated water bodies.

I would like to thank you for the opportunity to appear before this body and describe the objectives and approach of Living Lakes in this necessary endeavor.

As we experience the results of our efforts, they will be made available to any and all interested parties. Thank you.

[Testimony resumes on p. 396.]

[The prepared statement of Mr. Emler follows:]

Aquatic Liming and Fish Restoration:
A Demonstration Program

Testimony Submitted to

Subcommittee on Health and the Environment
Committee on Energy and Commerce
U.S. House of Representatives

By

Paul Emler, Jr.
Director Field Operations
Living Lakes, Inc.

1090 Vermont Avenue, N.W.
Suite 510
Washington, D.C. 20005

May 1, 1986

Good morning, I am Paul Emler, Jr., Director of Field Operations for Living Lakes, Inc. I want to tell you what Living Lakes, Inc. is, what our objectives are, and our program plan for accomplishing those objectives.

As you know, significant attention has been focused on acidification of lakes and streams in several areas of the United States and Canada. Research has been conducted by both government and industry to test theories and develop other theories regarding the causes of acidification. These research programs are producing useful results concerning the source and extent of acidification.

Continual control of industrial emissions, as required by the Clean Air Act; commercialization of new clean-coal technologies; and further research are all necessary to meet the desire for environmental protection.

However, in concert with these actions, a program to mitigate acidic conditions in which lakes and streams, acidified by means other than acid mine drainage, local point sources, or, which are naturally acidic water bodies, will be needed to complete any effective and judicious plan to deal responsibly with environmental effects of aquatic acidification.

Liming is an effective and proven technology that can be used today to deal responsibly with the effects of aquatic acidification. Extensive successful management of aquatic acidity in Sweden and research investigations conducted by both industry and government in the U.S. show significant promise and encourage broader application of liming technologies.

LIVING LAKES, INC. STAFF

Living Lakes, Inc. (LLI) was established in January 1986, to design and implement an applied fisheries management field demonstration program for waters acidified by causes other than point source discharges, acid mine drainage, or naturally acidic aquatic conditions. LLI is a not-for-profit corporation funded solely by industry. It has a Board of Directors, comprised of Chief Executive Officers from participating organizations, which sets objectives and provides policy direction and financial support. An Operating Committee, consisting of Senior Executives, principally from participating organizations, is responsible for achieving stated objectives; conformance with policy; and fiscal, personnel, and contract management. The Executive Director, Dr. Robert Brocksen, has responsibilities for the development and implementation of the lake and stream treatment program and corporate administration. A Scientific Advisory Panel has been established to assist in program design, review of continuing technical and operational activities, and the technical and scientific validity of the program.

GENERAL OBJECTIVES

The overall objective of the LLI program is to demonstrate that cost-effective management techniques are available to restore acidified and acid-stressed aquatic ecosystems. Specific objectives are defined by the type of project designated for individual lake or stream sites. These objectives include: mitigative liming for the chemical neutralization of acidic aquatic systems; protective liming for the chemical neutralization of acid sensitive systems in order to protect ecologically important fisheries populations; and research which will be initiated to enhance the effectiveness or applicability of future liming operations.

LIVING LAKES, INC. STAFF

EXECUTIVE DIRECTOR	DR. ROBERT BROCKSEN
DIRECTOR, FIELD OPERATIONS	MR. PAUL EMLER, JR.
EXECUTIVE ASSISTANT	MS. LESLIE DeMARCO
SECRETARY/RECEPTIONIST	MS. DONNA EINARSON

GENERAL OBJECTIVE

TO DEMONSTRATE COST-EFFECTIVE
MANAGEMENT TECHNIQUES ARE
AVAILABLE TO RENOVATE ACIDIFIED AND
ACID-STRESSED AQUATIC ECOSYSTEMS.

OBJECTIVES

- MITIGATIVE LIMING
  - CHEMICAL NEUTRALIZATION OF ACIDIC AQUATIC SYSTEMS
- PROTECTIVE LIMING
  - CHEMICAL NEUTRALIZATION OF ACID-SENSITIVE AQUATIC SYSTEMS TO PROTECT ECOLOGICALLY IMPORTANT FISHERIES POPULATIONS
- RESEARCH
  - INITIATED TO ENHANCE EFFECTIVENESS OR APPLICABILITY OF FUTURE LIMING OPERATIONS

LLI OUTREACH ACTIVITIES

We, at LLI, have presented our program to individuals in the Federal government, state governments, and industry and environmental organizations to inform them of who we are, and what our objectives are. Contacts have also been made with various state officials for permission and cooperation to conduct our program in their respective states. Specifically, we have contacted:

Dr. Peter Oatis, Assistant Director Fisheries,
Massachusetts Division of Fisheries & Wildlife

Dr. Lee Zini, Director, Office of Tidewater Administration,
Maryland Department of Natural Resources

Mr. Ron Lawrenz, Ecological Services,
Minnesota Department of Natural Resources

Mr. Ken Warren, New Hampshire Water Supply and Pollution Control Division

Mr. Walt Kretser, Director, Adirondack Lake Survey Corporation, New York

Dr. Dean Arnold, Pennsylvania Cooperative Fisheries Unit

Dr. John Cronan, Chief, Rhode Island Division of Fish and Wildlife

Dr. Tom Weaver, Tennessee Office of Water Management

LLI OUTREACH ACTIVITIES

Federal:	Executive Office of the President U.S. Fish and Wildlife Service
States:	MA, MD, MN, NH, NY, PA, RI, TN, WV, WY
Other:	Sport Fishing Institute North American Lake Management Society Automotive Manufacturers Association Utility Air Regulatory Group Empire State Electric Energy Corporation Edison Electric Institute Environment & Energy Committee Electric Power Research Institute

Dr. Ron Potesta, Director, West Virginia Department of
Natural Resources

Dr. Robert Wiley, Chief of Fisheries Research, Wyoming
Game and Fish Department

PROGRAM DESIGN

Now I would like to give you an overview of the technical aspects of our program. It is designed as a multi-component program and encompasses: site characterization and selection; dose estimation; application technique determination; system treatment; fish stocking; system monitoring; lake reapplication if needed; and stream treatment adjustment.

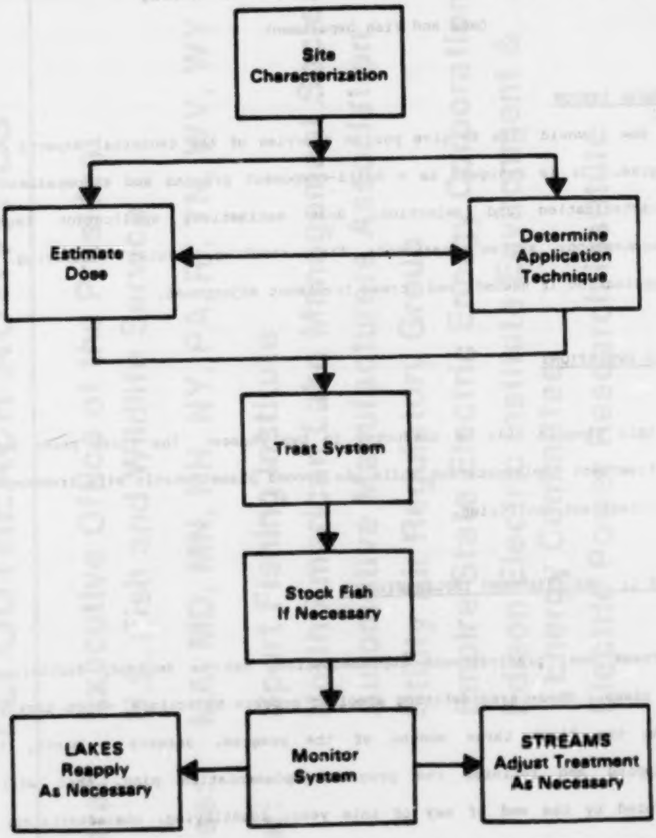
FIELD OPERATIONS

This program will be conducted in two phases. The first phase entails pre-treatment implementation while the second phase details site treatment and post-treatment monitoring.

PHASE I: PRE-TREATMENT IMPLEMENTATION

Phase one, pre-treatment implementation, can be defined, further, into four tasks. These are: defining specific program objectives, which took place during the first three months of the program, January - March, 1986; developing and refining the program implementation plan, that will be completed by the end of May of this year; Identifying, characterizing, and selecting program sites, which is a continuing activity that also will occur during phase two; and designing site-specific treatment plans, also a continuing activity.

PROGRAM DESIGN


Site Characterization
Estimate Dose
Determine Application Technique
Treat System
Stock Fish If Necessary
LAKES Reapply As Necessary
Monitor System
STREAMS Adjust Treatment As Necessary

FIELD OPERATIONS

- **PHASE I:** PRE-TREATMENT IMPLEMENTATION
- **PHASE II:** TREATMENT & POST-TREATMENT MONITORING

PHASE I: PRE-TREATMENT IMPLEMENTATION

- **TASK 1:** DEFINE SPECIFIC PROGRAM OBJECTIVES
- **TASK 2:** DEVELOP/REFINE IMPLEMENTATION PLAN
- **TASK 3:** SELECT/CHARACTERIZE PROJECT SITES
- **TASK 4:** DESIGN SITE TREATMENT PLANS

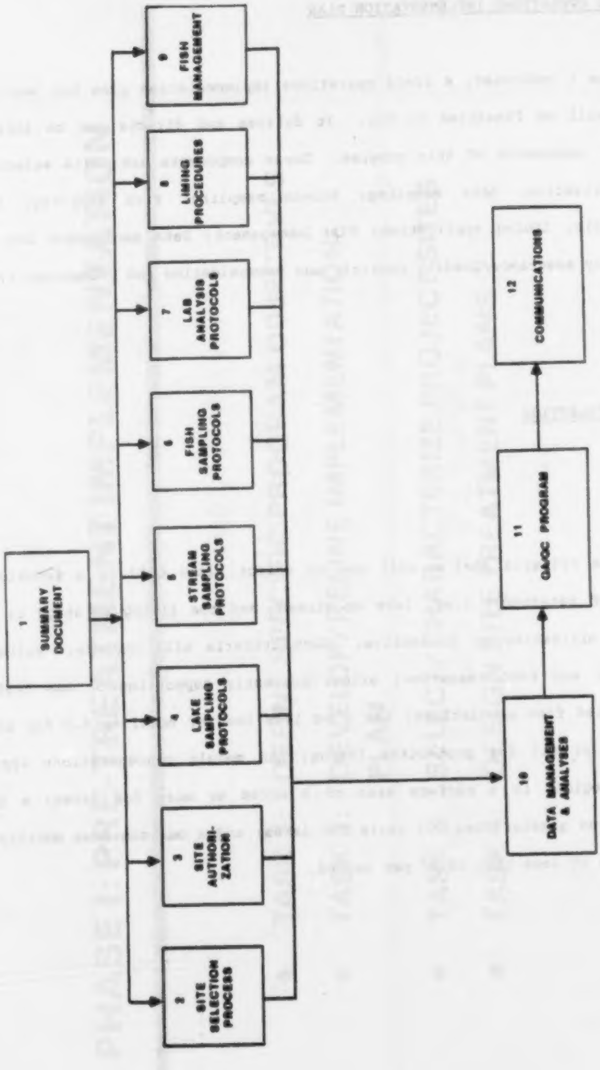
FIELD OPERATIONS IMPLEMENTATION PLAN

As I indicated, a field operations implementation plan has been developed and will be finalized in May. It defines and directs how to implement the major components of this program. These components are: Site selection; Site authorization; Lake sampling; Stream sampling; Fish sampling; Laboratory analysis; Liming application; Fish management; Data management and analysis; Quality assurance/Quality control; and Communication and technology transfer.

SITE SELECTION

The criteria that we will use to select sites will be a function of the type of waterbody: i.e., lake or stream; and the liming strategy to be used: i.e., mitigative or protective. Such criteria will include: suitable fish habitat and food resources; either currently supporting or has historically supported fish populations; has a pH less than or equal to 6.0 for mitigative liming or 6.5 for protective liming; has metals concentrations typical for that region; is a surface area of 5 acres or more for lakes; a hydraulic retention greater than 0.5 years for lakes; and a maximum mean monthly flow in streams of less than 50 m^3 per second.

FIELD OPERATIONS IMPLEMENTATION PLAN


1
SUMMARY DOCUMENT
2
SITE SELECTION PROCESS
3
SITE AUTHORI-ZATION
4
LAKE SAMPLING PROTOCOLS
5
STREAM SAMPLING PROTOCOLS
6
FISH SAMPLING PROTOCOLS
7
LAB ANALYSIS PROTOCOLS
8
LIMING PROCEDURES
9
FISH MANAGEMENT
10
DATA MANAGEMENT & ANALYSES
11
QA/QC PROGRAM
12
COMMUNICATIONS

SITE SELECTION CRITERIA
(MITIGATIVE LIMING)

CRITERIA APPLICABLE TO LAKES & STREAMS

- MUST HAVE SUPPORTED OR CURRENTLY SUPPORT FISH POPULATIONS
- MUST HAVE SUITABLE FISH HABITAT AND FOOD RESOURCES
- $pH \leq 6.0$, OR $ANC \leq 10$ ueq/l
- APPARENT COLOR < 100 PCUs
- METAL CONCENTRATIONS TYPICAL FOR REGION
- UNAFFECTED BY POINT-SOURCE DISCHARGES OR ACID MINE DRAINAGE
- NOT A LONG-ESTABLISHED NATURALLY ACIDIC SYSTEM

SITE SELECTION CRITERIA
(MITIGATIVE LIMING)

ADDITIONAL CRITERIA SPECIFIC TO LAKES

- HYDRAULIC RETENTION TIME $>$ 0.5 YEAR
- SURFACE AREA $\geq$2 ha (5 acres)

ADDITIONAL CRITERIA SPECIFIC TO STREAMS

- MAXIMUM MEAN MONTHLY FLOW $\leq$ 50 m^3/sec

SITE SELECTION CRITERIA
(PROTECTIVE LIMING)

DIFFERENT FROM MITIGATIVE LIMING CRITERIA

- SUPPORT BIOLOGICAL POPULATIONS/COMMUNITIES OF SPECIAL ECOLOGICAL IMPORTANCE
- IF STRESS DOCUMENTED, NOT FROM LOSS OF CRITICAL HABITAT OR FOOD RESOURCES
- pH≤6.5, OR ANC≤50 ueq/l
- IF NO STRESS DOCUMENTED, EVIDENCE OF DECLINING pH OR ANC

BASELINE DATA PURPOSE

We will collect pre-treatment baseline data to determine if site selection criteria have been met. Baseline data also will be used to estimate the dosage of neutralization materials and to develop an application strategy that is site-specific.

PRE-TREATMENT INFORMATION

This pre-treatment information will be collected from a variety of sources, particularly from various state agencies as they will have the most complete data base from which to draw our data. The kinds of baseline data that we will use include: water quality data; fisheries data; habitat data; soils and geology data; watershed data; lake morphology data; precipitation data; and site and watershed usage.

DESIGN SITE TREATMENT PLANS

After we have collected the pre-treatment baseline information, site-specific treatment plans will be developed. A plan will specify the application method and the neutralization materials to be used and the

PURPOSES OF PRE-TREATMENT BASELINE DATA

- DETERMINE IF SITE SELECTION CRITERIA ARE MET
- ESTIMATE CALCITE DOSAGE AND DEVELOP APPLICATION STRATEGY
- MEASURE SUCCESS

PRE-TREATMENT INFORMATION (LAKES)

- HISTORIC WATER QUALITY DATA
- HISTORIC FISH/BIOLOGICAL DATA
- HYDROLOGIC UNIT CODE AND MAP
- USGS 7.5' QUAD. MAP
- BEDROCK GEOLOGY MAP
- SOILS MAP
- WATERSHED AREA & MORPHOLOGY
- LAKE MORPHOMETRY & BATHYMETRY
- LOCATION OF INLETS, OUTLETS, & ACCESS POINTS

PRE-TREATMENT INFORMATION CONTINUED (LAKES)

- HYDROLOGIC DATA
- LONG-TERM PRECIPITATION/RUNOFF MAPS
- HYDRAULIC RETENTION TIME
- LAND COVER AND LAND USE
- LAKE USAGE
- NPDES PERMITS
- WATERSHED DISTURBANCES
- AERIAL PHOTOGRAPHS

DESIGN SITE TREATMENT PLANS

- SPECIFY APPLICATION METHOD AND NEUTRALIZATION MATERIALS FOR EACH SITE
- DETERMINE CALCITE DOSAGE FOR EACH SITE
- ESTIMATE TREATMENT AND MAINTENANCE COSTS FOR EACH SITE
- IDENTIFY ANY NECESSARY SITE-SPECIFIC MODIFICATIONS TO MONITORING PROGRAM
- PREPARE SITE-SPECIFIC TREATMENT PLANS

calcite dosage to be applied at a specific site. The plan also will estimate the treatment and maintenance costs, as well as identify any necessary modification to the post-treatment monitoring program.

PHASE TWO OBJECTIVES

Phase two involves the treatment of selected sites; fish stocking, if necessary; and post-treatment monitoring. The objectives of Phase II include: 1) for 1986, the treatment of up to 30 lake sites; the stocking of fish in these sites, if necessary; the implementation of post-treatment monitoring; and the analysis of data and report preparation; and 2) identifying and characterizing additional sites for treatment in 1987 by conducting baseline water quality surveys and baseline fish surveys.

LAKES APPROVED AND PERMITTING INITIATED

Thus far, nine lakes in Massachusetts have been approved for treatment in 1986. These include: Buckley Dunton Lake, Baker Pond; Curlew Pond; Lawrence Pond; Lout Pond; North Pond; Schoolhouse Pond; Schubael Pond; and Snake Pond.

The permitting process for six additional Massachusetts lakes has been initiated. These lakes are: Cahoon Pond; Griffiths Pond; Whites Pond; Burges Pond; Blackmere Reservoir; and North Triangle Pond.

PHASE II OBJECTIVES

- Treat Up To 30 Lake Sites During 1986
  - — Stock With Fish as Necessary
  - — Implement Post-Treatment Monitoring
  - — Analyze Data & Prepare Reports
- Identify and Characterize Additional Sites for Treatment in 1987
  - — Conduct Baseline Water Quality Surveys
  - — Conduct Baseline Fish Surveys

LAKES APPROVED FOR TREATMENT IN 1986

MASSACHUSETTS

LAKE	SIZE (ACRES)	COUNTY	TOWN
BUCKLEY DUNTON LAKE	175	BERKSHIRE	BECKET
BAKER POND	30	BARNSTABLE	ORLEANS
CURLEW POND	44	PLYMOUTH	PLYMOUTH
LAWRENCE POND	140	BARNSTABLE	SANDWICH
LOUT POND	18	PLYMOUTH	PLYMOUTH
NORTH POND	18	BERKSHIRE	FLORIDA
SCHOOLHOUSE POND	21	BARNSTABLE	CHATHAM
SCHUBAEL POND	57	BARNSTABLE	BARNSTABLE
SNAKE POND	84	BARNSTABLE	SANDWICH

PERMIT PROCESS INITIATED FOR TREATMENT IN 1986

MASSACHUSETTS

LAKE	SIZE (ACRES)	COUNTY	TOWN
CAHOON POND	28	BARNSTABLE	BREWSTER/HARWICH
GRIFFITHS POND	30	BARNSTABLE	BREWSTER
WHITES POND	24	PLYMOUTH	PLYMOUTH
BURGES POND	22	MIDDLESEX	WESTFORD
BLACKMERE RESERVOIR	25	PLYMOUTH	WAREHAM
NORTH TRIANGLE POND	20	PLYMOUTH	PLYMOUTH

FISH MANAGEMENT OBJECTIVE

The purpose of stocking fish in treated sites is to restore and maintain fisheries that have an economic, recreational, or ecological importance. The success of our program will be based on the successful restoration of fisheries in these treated water bodies.

MEASURES OF SUCCESS

The measures of our success are based on the kind of fishery that will be established at the treated sites. Those fisheries are: self-sustaining fishery, the survival and reproduction of stocked fish, and adequate growth and condition factors; put-grow-take fishery, the survival of stocked fish, adequate growth and condition factors; put and take fishery, the short term survival of stocked fish.

I want to thank you for the opportunity to appear before this body and describe the objectives and approach of Living Lakes, Inc. in this necessary endeavor. As we experience the results of our efforts, they will be made available to any and all interested parties.

FISH MANAGEMENT OBJECTIVE

RESTORATION/RENOVATION AND MAINTENANCE
OF AN ECONOMICALLY, RECREATIONALLY OR
ECOLOGICALLY IMPORTANT FISHERY.

MEASURES OF SUCCESS (MITIGATIVE LIMING)

SELF-SUSTAINING FISHERY	• SURVIVAL & REPRODUCTION OF STOCKED FISH • ADEQUATE GROWTH & CONDITION FACTORS
PUT-GROW-TAKE FISHERY	• SURVIVAL OF STOCKED FISH • ADEQUATE GROWTH & CONDITION FACTOR
PUT-AND-TAKE FISHERY	• SHORT-TERM SURVIVAL OF STOCKED FISH

Mr. **Waxman.** Thank you very much, Mr. Emler.

Mr. Uman.

STATEMENT OF MYRON F. UMAN

Mr. **Uman.** My name is Myron F. Uman and I appear before you today on behalf of the National Research Counsel of the National Academy of Sciences and National Academy of Engineering.

My purpose is to describe our recent report titled "Acid Deposition: Long-Term Trends." A copy of the summary of the report is submitted with my testimony for the record.

The report was prepared by an ad hoc committee of experts who served as volunteers under the chairmanship of Dr. James Gibson of the University of Colorado. Dr. Gibson regrets that he is unable to be here today.

The report is the fifth on the general topic of acid deposition that has been prepared under academy auspices since 1981. Each report was prepared by a separate ad hoc committee.

Two of the earlier reports were general assessments of the state of knowledge pertaining to specific aspects of the phenomenon. These reports with which the subcommittee is already aware treated respectively the environmental consequences of fossil fuel combustion in general and the physical transport and chemical transformation of precursor gases in the atmosphere.

The former report is known colloquially as the Schindler report and the latter as the Calvert report after the chairmen of the respective committees. The last four NRC reports on acid rain were prepared under my supervision.

The major findings of the Schindler report were that acidification of lakes had been observed only where the annual average pH of precipitation is less than about 4.7, that values less than this were prevalent over wide regions of eastern North America and that as a consequence if sensitive lake ecosystems were to be protected then deposition of acids would have to be reduced by about 50 percent. The report also stated that to achieve reductions of this magnitude, emissions of precursor gases would have to be reduced.

The Calvert study concluded that annual deposition of sulfate averaged over a wide region was essentially proportional to emissions and therefore that a 50-percent reduction in sulfur dioxide emissions would yield a proportionate reduction in sulfate deposition on average.

Under the chairmanship of Dr. Gibson, our most recent study gathered and evaluated a wide variety of historical data to test hypotheses regarding a number of environmental responses to emissions of precursor gases.

In the end, the focus was on emissions of sulfur oxides and environmental responses to deposition of acid sulfates because reliable historical data were just not available for emissions of oxides of nitrogen and environmental responses to deposition of acid nitrates.

The data were carefully reviewed for internal consistency and quality. Criteria were established for this review and some data did not pass muster. We concluded that considerable care must be taken to assure that the quality of data is known before the data are used in such analyses.

The findings and conclusions of the committee are presented in the report in considerable detail. Some conclusions about the acid rain phenomenon, while suspected or hypothesized for some time, have here been scientifically demonstrated.

For example, the report demonstrates that acidification of natural lakes has occurred in specific instances with concurrent reduction in the number of fish species and populations. While the conclusion may appear to be old hat to some, in fact the report provides the first conclusive scientific evidence of the effect.

In another case, dealing with linkages between emissions of sulfur oxides, the presence of atmospheric sulfates, the occurrence of sulfates in precipitation and its appearance in free-flowing streams, the committee was able to quantify the strength of the relationships statistically.

As a whole, the report presents a great deal of technical information and describes complex relationships. We can regret that the answers were not simple, but we cannot truthfully make simple statements when our understanding points to a complex phenomenon.

Put as simply as possible, the report confirms a number of presumed relationships between emissions and environmental responses, such as acidification of aquatic ecosystems, but demonstrates that the environmental responses are heterogeneous.

Not enough historical data exists to determine if acid rain is responsible for the observed declines being experienced by red spruce in the Northeastern United States. The scientific findings of the current report are consistent with those of the earlier NRC reports.

I would be happy to try to answer your questions about either how the report was prepared or what its findings are.

Thank you.

Mr. **Waxman**. Thank you, Mr. Uman.

Mr. Etchison.

STATEMENT OF DON ETCHISON

Mr. **Etchison**. Thank you, Mr. Chairman. My name is Don Etchison. I am the director of the Illinois Department of Energy and Natural Resources. It is a pleasure to be here today to talk to you on this important issue. I am here representing the State of Illinois and Governor Thompson.

We in Illinois share concern about this issue of acid rain. We recognize that it is an important international problem. However, we oppose this bill due to the serious impacts it has on the Illinois economy, coal industry and miners.

Illinois over the years has had perhaps the best clean coal program of any State in the Union. We have spent approximately $50 million over the last 6 years on coal research, basic and applied and also on coal demonstration projects. We have seven clean coal projects that are online now in Illinois.

During this same timeframe, Governor Thompson has played an active role both with the National Governors Association and with the Illinois delegation in Congress in urging the administration and other Federal officials to establish a Federal clean coal program.

We are very pleased about the action that Congress took to establish the Clean Coal Technology Program and the administration's endorsement of the special envoy report and we support those efforts wholeheartily.

On the impacts of H.R. 4567, as I said they are severe in Illinois. At a minimum case we estimate a total annual loss in sale of Illinois coal of 18 million tons under the provisions of the bill. This translates into nearly a 4,000 mining job loss with a total personal income loss of $400 million.

A worst case scenario shows a sales loss of 42 million tons sale of Illinois coal annually, a job loss of 9,000 miners and a net income loss of $900 million.

I should also point out that Illinois already has 4,000 unemployed miners and many of the counties in southern Illinois where the coal is produced have an unemployment rate exceeding 20 percent.

In addition to this loss, of course, there is the increased utility rates for the average consumer.

Another drawback of this bill that hits Illinois particularly hard is the NO_x provisions. This is a special case because we have an extraordinary number of cyclone boilers in the State of Illinois, some 23 of them, and our analysts tell me that this represents 25 percent of all those in the world and there is no economically proven way to reach the NO_x emission limit established by your bill.

In other words, those 23 boilers would have to be shut down. There is just no economical way to comply.

As an alternative to this bill we suggest an endorsement of the special envoy report and urge the administration and the Congress to provide funding to implement the Clean Coal Technology Program during the next 5 years.

Illinois is not asking for the Federal Government to finance the whole burden. Our Illinois program has been a cost-sharing approach and that is what we endorse and think would be a wise course for the Congress to pursue. We think that would be an equitable way, the new technologies, and implementing those and getting them on stream can be an important way to deal with the acid rain problem in a cost effective way rather than forcing utilities to scrub or purchase low sulfur coal. This would create punitive hardships that would cause serious economic damage to the Midwestern States and particularly Illinois.

I would be happy to answer any of your questions.

[Testimony resumes on p. 412.]

[The prepared statement of Mr. Etchison follows:]

Testimony of Dr. Don Etchison
Director, Illinois Department of Energy and Natural Resources

Subcommittee on Health and Environment-Committee on Energy and Commerce
on
HR 4567, "The Acid Deposition Control Act of 1986"
Washington, D.C.
May 1, 1986

GOOD MORNING. MY NAME IS DON ETCHISON, AND I AM THE DIRECTOR OF THE ILLINOIS DEPARTMENT OF ENERGY AND NATURAL RESOURCES. I WELCOME THIS OPPORTUNITY TO SPEAK TODAY, ON BEHALF OF GOVERNOR THOMPSON, ABOUT THE NEGATIVE IMPACTS OF HR 4567, THE "ACID DEPOSITION CONTROL ACT OF 1986". ILLINOIS RECOGNIZES THAT ACID RAIN IS A SERIOUS INTERNATIONAL PROBLEM WHICH DESERVES CAREFUL STUDY AND RESPONSE. HOWEVER, WE ARE UNALTERABLY OPPOSED TO LEGISLATION THAT PLACES AN UNDUE BURDEN ON OUR CITIZENRY AND ECONOMY AS A SOLUTION TO THE PROBLEM.

THE IMPORTANCE OF THIS ISSUE TO ILLINOIS IS REFLECTED IN THE ACTIVE ROLE THE STATE HAS TAKEN IN BASIC SCIENTIFIC RESEARCH AND THE DEMONSTRATION OF NEW AND INNOVATIVE CLEAN COAL TECHNOLOGIES. ILLINOIS HAS INVESTED MORE THAN ANY OTHER STATE IN COAL RESEARCH AND DEVELOPMENT. TO DATE, OVER $50 MILLION OF STATE FUNDS HAVE BEEN PROVIDED TO DEVELOP NEW RESEARCH AND DEMONSTRATION PROJECTS. FURTHERMORE, GOVERNOR THOMPSON HAS URGED THE FEDERAL GOVERNMENT TO ADOPT A CLEAN COAL TECHNOLOGY COST-SHARING PROGRAM FOR MANY YEARS. NOW THAT THE PRESIDENT HAS AGREED TO SUCH A PROGRAM, WE BELIEVE IT SHOULD BE GIVEN SOME TIME TO WORK.

WHILE THIS BILL IS BEING HERALDED AS A "COMPROMISE" WHICH WOULD SPREAD THE APPROXIMATELY $4 TO $5 BILLION ANNUAL COST TO REDUCE AIR POLLUTANTS ACROSS THE COUNTRY, MEMBERS OF THE SUBCOMMITTEE SHOULD KNOW THAT AS CURRENTLY DRAFTED, THE BILL EFFECTIVELY KILLS THE ILLINOIS COAL INDUSTRY AS IT EXISTS TODAY.

BECAUSE THE BILL ALLOWS EACH STATE TO MEET EMISSION REDUCTIONS BY EITHER SWITCHING TO LOW SULFUR COAL OR BY INSTALLING SCRUBBERS, IT IS ANTICIPATED THAT ILLINOIS WILL LOSE A MINIMUM OF 13.8 MILLION TONS OF COAL EXPORTS TO OTHER STATES. THIS TRANSLATES INTO A LOSS OF 3,000 MINING JOBS. MOREOVER, THE IMPACT OF COAL SWITCHING AND INCREASED UTILITY COST WILL CAUSE SEVERE DAMAGE TO THE COAL INDUSTRY, EMPLOYMENT, AND ILLINOIS' ECONOMY IN GENERAL.

NEGATIVE IMPACTS ON ILLINOIS

ILLINOIS WILL BE ONE OF THE MOST SEVERELY IMPACTED STATES, IF NOT THE MOST SEVERELY IMPACTED STATE, ECONOMICALLY, UNDER HR 4567. THIS BILL WOULD DO TWO THINGS TO ILLINOIS: IT WOULD DRAMATICALLY REDUCE COAL SALES AND RAISE UTILITY RATES. ULTIMATELY, OF COURSE, THESE TRANSLATE INTO JOBS; NOT ONLY COAL MINING JOBS, BUT ALSO JOBS RELATED TO THE COAL INDUSTRY AND JOBS LOST BECAUSE UTILITY CUSTOMERS WILL HAVE FEWER DOLLARS TO SPEND IN THE LOCAL ECONOMY. THE UNEMPLOYMENT RATE IN ILLINOIS IS ALREADY CLOSE TO 9 PERCENT. MANY COUNTIES IN SOUTHERN ILLINOIS, WHERE OUR COAL IS MINED, HAVE 20 PERCENT UNEMPLOYMENT, WITH 4,000 MINERS OUT OF WORK AND SEVERAL COAL MINES ALREADY CLOSED.

THE ILLINOIS DEPARTMENT OF ENERGY AND NATURAL RESOURCES ESTIMATES THAT AS A CONSEQUENCE OF ENACTING THIS LEGISLATION, ASSUMING THE BEST CASE SCENARIO, AND LOOKING ONLY AT THE EFFECTS OF THE SO_2 REDUCTIONS, COAL PRODUCTION WILL BE REDUCED BY 18 MILLION TONS, (OF WHICH 13.8 MILLION TONS IS EXPORTED) OR 30 PERCENT. THIS WOULD ENDANGER 3,700 MINING JOBS. PERSONAL INCOME OF ALL ILLINOISANS WOULD BE REDUCED BY $382.5 MILLION, WHILE COAL COMPANIES' SALES WOULD BE REDUCED BY $537 MILLION.

HOWEVER, OUR ANALYSTS BELIEVE THE RAMIFICATIONS OF THIS BILL COULD BE EVEN MORE DEVASTATING. ILLINOIS EXPORTS ABOUT TWO-THIRDS OF ITS COAL, OR ABOUT 40 MILLION TONS A YEAR. SINCE THE EFFECTS OF THE BILL ON OUR COAL INDUSTRY DEPEND SO MUCH ON THE DECISIONS MADE BY OUR OUT-OF-STATE CUSTOMERS, IT IS FEASIBLE UNDER A WORSE CASE SCENARIO THAT ILLINOIS COAL PRODUCTION COULD BE REDUCED BY AS MUCH AS 42 MILLION TONS, OR 70 PERCENT. THIS TRANSLATES TO JOB LOSSES FOR 8,750 MINERS. PERSONAL INCOME LOSSES COULD SOAR TO $897 MILLION. COAL COMPANIES WOULD LOSE $1.3 BILLION IN COAL SALES. IN SHORT, CLOSED COAL MINES AND UNEMPLOYED MINERS WILL SPELL DISASTER FOR BUSINESSES AND COMMUNITIES IN CENTRAL AND SOUTHERN ILLINOIS.

THE BURDEN OF THIS LEGISLATION WILL ALSO BE SHOULDERED BY OUR UTILITIES AND RATEPAYERS. IN A STUDY CONDUCTED FOR THE EDISON ELECTRIC INSTITUTE, AVERAGE RATE INCREASES AMONG THE MAJOR ELECTRIC UTILITIES IN ILLINOIS WERE ESTIMATED TO RANGE FROM 5 PERCENT TO 36 PERCENT DURING THE FIRST FIVE YEARS OF COMPLIANCE. USING 1986 DOLLARS, ANNUAL COMPLIANCE COSTS FOR THE FIRST FIVE YEARS RANGE FROM A LOW OF $15 MILLION AT CENTRAL ILLINOIS LIGHT COMPANY IN PEORIA TO A HIGH OF $336 MILLION FOR COMMONWEALTH EDISON IN CHICAGO.

THREE UTILITIES IN THE STATE WILL EXPERIENCE RATE INCREASES OF 20 PERCENT OR MORE. TWO OF THESE THREE UTILITIES SERVE ONE QUARTER OF OUR POPULATION WHICH ALREADY LIVES IN AN ECONOMICALLY DEPRESSED AREA. RATE INCREASES OF THIS MAGNITUDE WILL HAVE SEVERE CONSEQUENCES FOR CUSTOMERS SERVED BY MAJOR GENERATING UTILITIES AND NON-GENERATING RURAL COOPERATIVES ALIKE. WITH

STATEWIDE UNEMPLOYMENT STILL ABOVE THE NATIONAL AVERAGE, A FRAGILE FARM ECONOMY, AND A SIGNIFICANT LOSS OF JOBS IN THE MANUFACTURING SECTOR OVER THE PAST FIVE YEARS, THE TIMING AND APPROACH OF HR 4567 COULD NOT BE WORSE FOR ILLINOIS.

YET ANOTHER DRAWBACK FOR ILLINOIS' UTILITIES WILL RESULT FROM THE BILL'S PROPOSED 0.6 lbs. PER MILLION Btu STANDARD FOR NO_x. APPROXIMATELY 25 PERCENT OF ALL OF THE CYCLONE FIRED BOILERS IN THE WORLD ARE LOCATED IN ILLINOIS, ACCOUNTING FOR 60 PERCENT OF THE COAL CONSUMED ANNUALLY IN OUR STATE. CYCLONE BOILERS, WHICH EMIT ABOUT 2.6 lbs. PER MILLION Btu OF NO_x, CANNOT BE ECONOMICALLY OR RELIABLY RETROFITTED TO MEET THE NO_x STANDARDS CONTAINED IN HR 4567. ALTHOUGH FLUE GAS TREATMENT PROCESSES FOR NO_x RETROFITS ARE BEING USED IN JAPAN ON OIL AND COAL FIRED UNITS, THEIR CAPITAL COSTS ARE ESTIMATED AT 10 TIMES THAT OF REPLACEMENT BURNERS, THEIR OPERATING COSTS ARE SUBSTANTIAL, AND BOILER RELIABILITY IS AFFECTED. GIVEN THESE HIGH COSTS AND LOW RELIABILITY, UTILITIES WOULD HAVE LITTLE OTHER OPTION THAN TO RETIRE THE 23 CYCLONE BOILERS IN ILLINOIS.

ANALYSIS OF HR 4567

HR 4567 HAS BEEN CHARACTERIZED AS A FLEXIBLE AND COST-EFFECTIVE APPROACH TO ACID DEPOSITION. THE BILL ALLOWS ANY FORM OF EMISSION CONTROL TECHNOLOGY AND USES A TWO-PHASED APPROACH TO ACHIEVE SULFUR DIOXIDE AND NITROGEN OXIDE EMISSION REDUCTIONS. HOWEVER, THE BILL IS MUCH LESS FLEXIBLE THAN IT APPEARS TO BE.

OUR DISCUSSIONS WITH ILLINOIS UTILITIES INDICATE THAT THEY WILL HAVE NO ECONOMIC INCENTIVE TO FOLLOW THE COMPLIANCE SCHEDULE OF MEETING THE 2 lbs. PER MILLION Btu SO_2 LIMITATION IN 1993, AND FOUR YEARS LATER, MEETING AN ADDITIONAL 1.2 lbs. LIMITATION. THEY ARE MORE LIKELY TO DECIDE TO MEET THE FINAL LIMIT OF 1.2 lbs. PER MILLION Btu INITIALLY AND IGNORE THE PHASED APPROACH. FURTHER, THERE ARE ONLY TWO REAL OPTIONS FOR UTILITIES USING ILLINOIS BASIN COAL: SCRUB OR SWITCH. COAL SWITCHING IS THE MORE ATTRACTIVE OF THE TWO OPTIONS SINCE RETROFITTING REQUIRES A LARGE INITIAL CAPITAL INVESTMENT, ESPECIALLY FOR OLDER PLANTS. UTILITIES ARE LIKELY TO SWITCH TO BURN COMPLIANCE COAL, OR RETIRE THEIR OLDER COAL FIRED PLANTS.

IF ENACTED, HR 4567 WOULD SEVERELY ENDANGER THE RESEARCH AND DEVELOPMENT OF COST-EFFECTIVE NEW TECHNOLOGIES TO CONTROL EMISSIONS FROM EXISTING COAL-FIRED PLANTS. THERE IS A NEW GENERATION OF INNOVATIVE TECHNOLOGIES FOR RETROFITTING THESE PLANTS WHICH WOULD REDUCE SULFER EMISSIONS BY 50 TO 60 PERCENT AND GREATLY REDUCE NITROUS OXIDE EMISSIONS--AT A FRACTION OF THE CAPITAL COSTS REQUIRED FOR THE FLUE GAS SCRUBBERS CURRENTLY AVAILABLE. IF GIVEN A CHANCE THROUGH DEMONSTRATION PROJECTS AND FURTHER REFINEMENT, THESE NEW SYSTEMS WOULD MAKE A SIGNIFICANT CONTRIBUTION TO IMPROVING AIR QUALITY IN THE 1990s. BUT FURTHER WORK IS NEEDED. ILLINOIS ADVOCATES THE DEVELOPMENT OF SUCH SYSTEMS AS A POSITIVE AND CONSTRUCTIVE APPROACH TO AIR QUALITY ISSUES INSTEAD OF THE DRASTIC AND DISRUPTIVE MEASURES WHICH THIS BILL PROPOSES.

THE FINANCING PROGRAM FOR POLLUTION CONTROL EQUIPMENT IN HR 4567 SOUNDS BENEFICIAL AT FIRST READING, BUT UPON FURTHER SCRUTINY, PROVIDES LITTLE ASSISTANCE IN MEETING THE ASTRONOMICAL COSTS OF THE BILL. THE SUBSIDY PROGRAM ONLY COVERS THE DEBT SERVICE ON CAPITAL INVESTMENT FOR ENVIRONMENTAL CONTROL -- NOT THE RECOVERY OF THE INVESTMENT ITSELF OR THE OPERATING AND MAINTENANCE COSTS. SINCE THE TRIGGER MECHANISM FOR ELIGIBILITY IS A 10 PERCENT INCREASE IN RESIDENTIAL RATES DUE SOLELY TO THE ADDITIONAL COSTS OF BORROWING FUNDS TO PAY FOR THE ENVIRONMENTAL EQUIPMENT, IT IS UNLIKELY THAT MANY UTILITIES WILL QUALIFY FOR THE SUBSIDY. FOR EXAMPLE, GIVEN THE LARGE NUCLEAR BASE OF ILLINOIS' COMMONWEALTH EDISON, THIS COMPANY DEFINITELY WOULD NOT RECOVER THE DEBT SERVICE PAYMENTS FOR A FLUE GAS DESULFURIZATION RETROFIT OF ITS 1,300 MEGAWATT KINCAID POWER PLANT. THE COMPANY WOULD PROBABLY BE FORCED TO RETIRE THE KINCAID PLANT AND SHIFT LOAD TO ITS NUCLEAR AND LOW SULFUR COAL UNITS.

RECOMMENDATIONS

ILLINOIS SUGGESTS AS AN ALTERNATIVE TO HR 4567, FUNDING AND IMPLEMENTATION OF THE JOINT REPORT OF THE SPECIAL ENVOYS ON ACID RAIN, RECENTLY ENDORSED BY PRESIDENT REAGAN.

THIS REPORT, ALSO KNOWN AS THE LEWIS-DAVIS REPORT, IS THE FINAL PRODUCT OF A YEAR-LONG EFFORT AFTER PRESIDENT REAGAN AND PRIME MINISTER MULRONEY'S MEETING OF MARCH 17-18, 1985. AT THAT MEETING, ACID RAIN WAS RECOGNIZED BY BOTH LEADERS AS A SERIOUS INTERNATIONAL CONCERN. DREW LEWIS, SPECIAL ENVOY TO

PRESIDENT REAGAN, AND WILLIAM DAVIS, SPECIAL ENVOY TO CANADIAN PRIME MINISTER MULRONEY, WERE APPOINTED TO MAKE AN INDEPTH EXAMINATION AND REPORT ON INTERNATIONAL ENVIRONMENTAL PROBLEMS ASSOCIATED WITH TRANSBOUNDARY AIR POLLUTION. ON JANUARY 8, 1986, AFTER EXTENSIVE STUDY OF THE SCIENTIFIC, ECONOMIC AND POLITICAL ASPECTS OF THE ACID RAIN ISSUE, THE SPECIAL ENVOYS PRESENTED THEIR JOINT REPORT ON TRANSBOUNDARY ACID RAIN.

BEYOND THE RECOGNITION OF THE INTERNATIONAL NATURE OF ACID RAIN, THE REPORT MAKES THREE KEY RECOMMENDATIONS: 1) THE INITIATION OF A 5 YEAR, $5 BILLION PROGRAM FOR COMMERCIAL DEMONSTRATION OF CLEAN COAL TECHNOLOGY; 2) A COMMITMENT TO ONGOING COOPERATIVE ACTIVITIES, INCLUDING BILATERAL CONSULTATIONS AND INFORMATION EXCHANGE; AND 3) A GREATER EMPHASIS ON CARRYING OUR RESEARCH ESSENTIAL TO RESOLVING TRANSBOUNDARY ACID RAIN ISSUES.

ON MARCH 5TH OF THIS YEAR, GOVERNOR THOMPSON URGED THE PRESIDENT TO ADOPT THE REPORT'S RECOMMENDATION FOR A CLEAN COAL PROGRAM (ATTACHMENT ONE). PRESIDENT REAGAN ENDORSED THE REPORT ON MARCH 18TH. THE RECOMMENDED COMMERCIAL DEMONSTRATION PROGRAM WOULD ENCOURAGE GOVERNMENT AND INDUSTRY TO WORK TOGETHER TO CONTROL ACID RAIN. GOVERNMENT WOULD PROVIDE ONE-HALF OF THE FUNDING, $2.5 BILLION, FOR PROJECTS IN WHICH INDUSTRY IS PREPARED TO CONTRIBUTE THE REMAINING HALF.

ILLINOIS HAS SHOWN ITS SUPPORT OF SUCH PUBLIC-PRIVATE PARTNERSHIPS BY OUR INVOLVEMENT IN THE FEDERAL CLEAN COAL TECHNOLOGY PROGRAM ESTABLISHED BY CONGRESS IN 1985. WITH GOVERNOR THOMPSON'S URGING, FOUR CLEAN COAL TECHNOLOGY

PROPOSALS AIMED AT THE USE OF ILLINOIS COAL WERE RECENTLY SUBMITTED TO THE U.S. DEPARTMENT OF ENERGY. THREE OF THE PROPOSALS UTILIZE DRY SORBENT INJECTION TECHNOLOGIES IN RETROFIT APPLICATIONS. THE FOURTH PROPOSAL IS AN ILLINOIS/WISCONSIN PROJECT IN WHICH ILLINOIS COAL IS USED IN DEMONSTRATION OF A MILWAUKEE, WISCONSIN 80-MEGAWATT TURBOCHARGED BOILER.

EVEN THOUGH PRESIDENT REAGAN HAS ENDORSED THE LEWIS-DAVIS REPORT, NO BUDGET REQUEST HAS BEEN PROPOSED TO IMPLEMENT THE REPORT'S FINDINGS. WE IN ILLINOIS URGE CONGRESS TO PROVIDE FUNDING FOR THIS IMPORTANT PROGRAM. AS PREVIOUSLY MENTIONED, ILLINOIS HAS SHOWN ITS COMMITMENT BY FUNDING OVER $50 MILLION IN COAL PROJECTS OVER THE LAST FIVE YEARS. OUR PROGRAMS INCLUDE: 1) $42.9 MILLION FOR DEMONSTRATIONS OF COAL GASIFICATION, ADVANCED FLUE GAS DESULFURIZATION, AND FLUIDIZED BED BOILERS;) 2) $8.8 MILLION FOR BASIC AND APPLIED RESEARCH; AND 3) RECENT IMPLEMENTATION OF A $55 MILLION LOAN PROGRAM FOR ILLINOIS INDUSTRY TO CONVERT TO ILLINOIS COAL USING CLEAN COAL TECHNOLOGIES (ATTACHMENT TWO).

IN CONCLUSION, WE IN ILLINOIS ARE CONCERNED ABOUT ACID RAIN AND ARE DILIGENTLY PURSUING RATIONAL, COST-EFFECTIVE METHODS TO REDUCE EMISSIONS. ILLINOIS IS DEVELOPING NEW TECHNOLOGY, WHILE COMMITTING SIGNIFICANT RESOURCES TO COMPLY WITH FEDERAL LAWS THAT REQUIRE UTILITIES TO MEET CURRENT EMISSION REDUCTIONS. WE CAUTION THE CONGRESS AGAINST TAKING THE DRASTIC MEASURES IN HR 4567. THE CLEAN COAL TECHNOLOGY PROGRAMS SHOULD BE GIVEN THE OPPORTUNITY TO DEMONSTRATE THEIR EFFECTIVENESS IN ADDRESSING THE ACID RAIN ISSUE. TO JUMP TO THE COSTLY AND POSSIBLY INEFFECTIVE PROGRAM PROPOSED IN THIS BILL IS ILL-ADVISED AND WOULD SURELY NOT BE WORTH THE PRICE IT WOULD EXACT.

THANK YOU FOR YOUR CONSIDERATION.

ATTACHMENT ONE-GOV. THOMPSON, LETTER TO THE PRESIDENT ON ACID RAIN
ATTACHMENT TWO-ILLINOIS COAL DEVELOPMENT PROGRAM

STATE OF ILLINOIS
ATTACHMENT ONE

STATE OF ILLINOIS
OFFICE OF THE GOVERNOR
SPRINGFIELD 62706
JAMES R. THOMPSON
GOVERNOR

March 5, 1986

The Honorable Ronald Reagan
President
The White House
1600 Pennsylvania Avenue
Washington, D.C. 20050

Dear President Reagan:

I want to congratulate you on the progress that has been made in our nation's dialogue with the Canadian Government on transboundary acid rain. Your agreement with Prime Minister Mulroney to appoint special envoys to examine the acid rain issue has resulted in a better understanding in both countries, as demonstrated in the joint report of special envoys Drew Lewis and William Davis. I read with great interest the joint report, as any federal action concerning acid rain is of great interest to Illinois due to our large and economically critical coal deposits.

The primary focus in the report on the need to develop innovative control strategies, including clean coal technologies, is highly appropriate. I urge you to work with the Congress to allocate the needed resources to meet the goal of the five year demonstration program recommended in the report. I am willing to help in any way that will make this demonstration program a reality. Further, I endorse the recommendation to establish a panel to oversee the research demonstration program. Illinois would be very pleased to participate on that panel, and I offer my assistance.

I have long been a proponent of research into clean coal technologies, and have allocated significant state resources to coal research efforts in Illinois. A recent report of the Illinois Department of Energy and Natural Resources has found that the Illinois basin contains over 1,000 years worth of coal. Illinois has vigorously pursued research and demonstration programs aimed at the clean, economical use of Illinois coal. Through its research and demonstration program, the State provides funding and other support at eleven universities and research institutions. This effort has an annual budget of

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PAGE 2.

$2.25 million, not including private sector or federal contributions. Research is currently concentrated in the areas of coal characterization and advanced cleaning.

Through the Coal Development Fund, the State provides capital bond funding to projects which demonstrate new and innovative coal utilization technologies. To date, $40 million of state funds have been provided to projects demonstrating coal gasification, fluidized bed boilers, and advanced scrubber technologies.

This year the Illinois General Assembly approved, at my urging a new program to provide low-interest loans to Illinois industries which convert to Illinois coal for their plants' power sources. New, more clean burning boilers are also eligible. The first year funding is $7.5 million for this five year $55 million program.

Illinois is making a substantial contribution to researching and developing clean coal technologies. I have also strongly supported federal clean coal programs, including the multi-year funding for the Clean Coal Technology Reserve Program which Congress authorized last year. This new program is aimed at demonstrations of innovative technologies which show that our nation's coal can be utilized in an environmentally acceptable and economical manner. The objectives of the program are similar to the recommendations made in the envoys' report. I applaud your recent decision to proceed this year with the Clean Coal Technology Program.

Illinois is willing to assist in any responsible acid rain control effort that recognizes the cost of controlling acid rain and avoids disproportionate economic impact on any one region or industry. The demonstration program recommended in the report is an excellent way to lay the foundation for acid rain control. As the Governor of a major industrial and large coal producing state, I appreciate the well reasoned approach by Drew Lewis and William Davis, and I look forward to assisting in the implementation of their recommendations.

Please feel free to call on me for assistance in this matter.

Sincerely,

James R. Thompson

James R. Thompson
GOVERNOR

STATE OF ILLINOIS

ATTACHMENT TWO

THE ILLINOIS COAL DEVELOPMENT PROGRAM

ILLINOIS STATE GOVERNMENT HAS PLACED A HIGH PRIORITY ON MAINTAINING AND EXPANDING MARKETS FOR COAL RESOURCES. THE STATE OF ILLINOIS HAS IMPLEMENTED A COMPREHENSIVE COAL DEVELOPMENT PROGRAM WHICH FOCUSES FINANCIAL, TECHNICAL AND SCIENTIFIC RESOURCES ON THE DEVELOPMENT OF CLEAN COAL TECHNOLOGIES. THE PRIVATE SECTOR, THE FEDERAL GOVERNMENT AND THE UNIVERSITY COMMUNITY ARE PARTNERS IN THIS EFFORT. CENTRAL PROGRAM ELEMENTS INCLUDE:

TECHNOLOGY DEVELOPMENT AND DEMONSTRATION: FURTHER MARKETS FOR ILLINOIS COAL ARE HIGHLY DEPENDENT ON THE COMMERCIALIZATION OF TECHNOLOGIES THAT CONTROL THE POLLUTANTS FORMED WHEN COAL IS BURNED. THE STATE OF ILLINOIS HAS COMMITTED $42.9 MILLION TO DATE FOR THE DEMONSTRATION OF NEW COAL TECHNOLOGIES THAT CAN MEET THE REQUIREMENTS OF ENERGY CONSUMERS IN WAYS THAT ARE EFFICIENT, ECONOMICAL AND ENVIRONMENTALLY CLEAN. WITH CO-SPONSORSHIP FROM THE PRIVATE SECTOR AND PUBLIC FUNDING SOURCES, ILLINOIS' CLEAN COAL TECHNOLOGY DEMONSTRATION PROJECTS REPRESENT NEARLY $300 MILLION IN INVESTMENTS WHICH WILL BRING PROMISING COAL TECHNOLOGIES TO THE COMMERCIAL MARKETPLACE. CURRENT TECHNICAL APPROACHES INCLUDE COAL GASIFICATION, ADVANCED FLUE GAS DESULFURIZATION, AND FLUIDIZED BED BOILER TECHNOLOGIES. IN ADDITION, ILLINOIS IS A CO-SPONSOR OF THREE PROPOSED DRY SORBENT INJECTION PROJECTS CURRENTLY UNDER CONSIDERATION BY THE U.S. DEPARTMENT OF ENERGY THROUGH THE CLEAN COAL TECHNOLOGY PROGRAM.

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ATTACHMENT TWO

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COAL RESEARCH: THE STATE OF ILLINOIS SUPPORTS BASIC AND APPLIED RESEARCH AIMED AT DEVELOPING METHODS FOR THE REMOVAL OF SULFUR AND OTHER POLLUTANTS FROM COAL, UNDERSTANDING THE CHEMICAL AND PHYSICAL PROPERTIES OF SULFUR WITHIN THE COAL MACERAL, AND THE CONVERSION OF COAL TO CLEAN FUELS AND CHEMICAL FEEDSTOCKS. ILLINOIS' CENTER FOR RESEARCH ON SULFUR IN COAL COORDINATES THIS RESEARCH STATEWIDE. ILLINOIS HAS PROVIDED A TOTAL OF $8.8 MILLION TOWARD THIS INITATIVE SINCE 1981.

COMMERCIALIZATION INCENTIVES: TO PROMOTE THE CLEAN USE OF COAL WITHIN THIS STATE, ILLINOIS HAS IMPLEMENTED A PROGRAM TO PROVIDE BELOW-MARKET INTEREST RATE LOANS FOR INDUSTRIAL FLUIDIZED BED BOILER SYSTEMS AND OTHER CLEAN COAL TECHNOLOGIES. LOAN REPAYMENTS FROM THE $55 MILLION PROGRAM WILL BE PLACED IN A REVOLVING FUND TO HELP FINANCE ADDITIONAL PROJECTS.

Mr. **Waxman**. I thank you very much for your testimony. I appreciate what you have had to tell us today. I don't have extensive questions. Dr. Uman, I would like to point out that you have described very well over the years. The National Academy of Sciences has contributed a great deal to our understanding of the acid rain problem and I congratulate you and your colleagues at the Academy for the work that you have done on this report and all the other acid rain reports as well.

Back in 1981 the Academy concluded that a 50-percent reduction in acid deposition would be necessary to protect the sensitive aquatic systems. Two years later NAS issued another acid rain study reaffirming its earlier conclusions and resolving uncertainty over whether reducing emissions would actually work to cut back acid rain, reduced sulfur and nitrogen oxide pollution over a broad area, the Academy concluded, and we would see a roughly proportional reduction in deposition.

Now the Academy has in effect closed the loop reaffirming its earlier reports with extensive analysis.

Could you please review for us those key areas of the new report where aspects of the acid rain problem were conclusively proven? I understand that the report conclusively links emissions of sulfur and nitrogen oxides to the acidification of stream waters and conclusively shows that lake acidification has eliminated fish populations.

Would you want to comment on that?

Mr. **Uman**. Yes, Mr. Chairman. I thank you for your kind remarks. The report deals principally with emissions of sulfur and the effects of acid sulfate. It does not deal with nitrate in the environment because the signals of nitrate in the environment don't last very long.

Our data go back 100 years and generally speaking nitrate disappears very quickly. Its effects are transient which is not to say unimportant but there is just no long term record for nitrate so your statement is correct if you excise the comments about nitrate.

As I indicated in my testimony, there are several important relationships that we have demonstrated we feel for the first time.

One has to do with the relationships between emissions of sulfur oxides, sulfur in the atmosphere, sulfur in precipitation and sulfur in streams. We find a cause/effect relationship between these phenomena with a reliability of 99.1 percent based on a statistical test.

The relationship then to sulfate in lakes is less certain principally because the resonance time of water in lakes is very long compared to the resonance time of water in streams so the chemistry of lakes is a function of a long period of time and, as a consequence, geochemical processes that go on in the watershed. These vary tremendously from watershed to watershed.

On the other hand, one set of data in our report, for 625 lakes stretching from Connecticut to Nova Scotia, does demonstrate the relationship between sulfur in precipitation and sulfur in lakes.

In addition, we have published the most extensive set of data so far on historical reconstructions of the pH in lakes. Unfortunately, there are not a great many of these sets of data available. We chose to look at lakes that were principally high altitude lakes that are in watersheds otherwise undisturbed by man so that we would not complicate the data with other disturbances such as from agriculture and what-not.

We were able to reconstruct the pH history of lakes for several hundred years. We find in certain lakes, in the 1930's, some in the 1940's and some in the 1950's, the pH of those lakes changed dramatically.

Concurrently with that, fish populations disappeared. There is a figure of this on page 33 of the summary for Big Moose Lake in New York.

Mr. WAXMAN. Let me ask you your opinion about the overall impact of this bill that we have introduced. According to analysis of ICF and OTA, this program will bring about a nationwide reduction in sulfur dioxide emissions of about 10 million tons by 1997.

The question I have for you is in short, will it work? That is, if we reduce sulfur dioxide emissions by 10 million tons over a widespread area of the United States, do you believe based on all of the Academy's reports that we will achieve a roughly proportionate and widespread reduction in acid sulfate deposition?

Mr. UMAN. Yes.

Mr. WAXMAN. Thank you very much. Mr. Luken.

Mr. LUKEN. Well, I am going to have to weigh it in there but this is the first time I have seen these. Dr. Uman, if I am reading from your summary here which was just handed out, one of the conclusions is, well, I will read the paragraph.

> Because of ambiguities regarding the assumptions employed in the historical New York survey, we cannot currently determine which of these results is most accurate and hence, we cannot quantify the number of New York lakes that have been affected by acid deposition.

Is that right?

Mr. UMAN. That is correct.

Mr. LUKEN. Would you want to explain that in any way?

Mr. UMAN. Certainly.

Mr. LUKEN. If you can't quantify the number of New York lakes that have been affected by acid deposition, then you can't come to much in the way of conclusions, can you?

Mr. UMAN. Well, all I can do is explain the data, Congressman.

The uncertainty that is described there is a technical one. It refers to data taken in the period 1928 to 1932 by chemists who were surveying lake chemistry in New York. In those days the method of measuring pH and alkalinity in lakes was the so-called colorometric technique.

You may remember it from chemistry where you drop little drops of indicator into the solution and then you add drop by drop a known acid until the solution changes color. The indicator is a dye which changes color when it reaches a particular pH.

The indicator that was used in the historical New York data was something called methyl orange and it happens to have two changes of color in the range in which the analysis was being done. The analysts did not write down in their notebooks which color change they were looking at. So there is some uncertainty in the New York data.

We did an analysis of the New York data in four different ways, three of them showed consistently on average an increase in acidity of that set of lakes of which I believe there are 240. The other method showed no change.

So that is why there is some uncertainty. It is a question of what in technical terms the end point of titration was in the methyl orange titration in 1928 to 1932.

Mr. **Luken**. The whole study is based on historical data.

Mr. **Uman**. That is correct, varying data sets that go back as far as 1880.

Mr. **Luken**. In looking at trends?

Mr. **Uman**. Yes, that is correct.

Mr. **Luken**. What is the result? What are the trends in the different parts of the country?

Mr. **Uman**. Well, Congressman, the emissions of sulfur dioxide——

Mr. **Luken**. What are the trends in Wisconsin?

Mr. **Uman**. Emissions of sulfur dioxide have changed over time and by looking at the changes over time and the changes in the environmental responses over time, one can make estimates of the extent to which those phenomena are statistically related.

Mr. **Luken**. The emissions or the acid deposition?

Mr. **Uman**. The environmental responses.

Mr. **Luken**. Responses to what?

Mr. **Uman**. To the sulfur in the atmosphere.

Mr. **Luken**. That is not emissions though.

Mr. **Uman**. Sure.

Mr. **Luken**. I thought you were talking about the deposition.

Mr. **Uman**. We related emissions to sulfur in the atmosphere to sulfur in the rain to sulfur in the water, OK, causal link one to the other.

Mr. **Luken**. What did you do? Where did you get the source of the emissions?

Mr. **Uman**. As in all emissions data, they are calculations. Our calculations were based on the consumption of coal by State which was further based on the origins of the coal that was burned in that State in 10-year increments. So ultimately, the emissions data rely upon the chemical analyses performed by the Bureau of Mines which are excellent, going back to the 1880's on the sulfur content of coal per mine.

We then studied where that coal was transported and how it was burned and on the basis of that calculated emissions on a State-by-State basis.

Mr. **Luken**. What did you find? Where did you find it was burned? Let's talk about the Adirondacks.

Mr. **Uman**. It is burned lots of places, Congressman.

Mr. **Luken**. I know.

Mr. **Uman**. One of the most interesting things we found is that emissions of sulfur dioxide in the Northeastern United States have been as high or were as high in 1920 as they were in 1970 so that, in fact, the acid deposition problem has been or at least the problem of emissions of sulfur dioxides has been around a long time.

Mr. **Luken**. They were as high in 1920 as 1985?

Mr. **Uman**. 1970. It is reduced now somewhat in the northeast from 1970. We find, in fact, there are lakes in New York State that became acidified in the 1930's. Since these lakes were in——

Mr. **Luken**. You mean the fish didn't die recently? They died in the 1930's?

Mr. **Uman**. There are lakes in which the lakes became acidified and the fish populations were reduced in the 1930's, that is correct.

Mr. **Luken**. That is when the fish died?

Mr. **Uman**. Yours is a universal statement, Congressman.

Mr. **Luken**. Put yourself in my position here. You are not really saying much. You are saying that is not a universal statement. You can't quantify it. So how do you come to that conclusion? How do you prove any conclusion that you draw?

Mr. **Uman**. We have data on some lakes that show this phenomena occurred in the 1930's. We have data on other lakes——

Mr. **Luken**. How many lakes?

Mr. **Uman**. Off the top of my head, I don't know how many in the 1930's.

Mr. **Luken**. Is it in here?

Mr. **Uman**. Yes. It is in the full report and copies are available to the subcommittee.

Mr. **Waxman**. Will the gentleman yield to me?

Mr. **Luken**. Yes, I will yield.

Mr. **Waxman**. Is there enough evidence to show a causal link between the pollution that is going up in the air and the damage that is being done? Isn't that the key conclusion of the report?

Mr. **Uman**. I believe it is, Congressman, but one has to be a little careful about the damage you are talking about. There is no evidence currently that what is going up is affecting the trees but as far as the aquatic ecosystems are concerned, we think there is that evidence.

Mr. **Luken**. Would you point that out to us in the report?

Mr. **Uman**. Which one, Congressman?

Mr. **Luken**. The conclusion on the damage to the aquatic systems. I guess that is what you were referring to and the causal relationship.

Mr. **Uman**. If you look at the findings and conclusions beginning on page 6 in the summary.

Mr. **Waxman**. Mr. Luken, your time has expired on this questioning.

Mr. **Luken**. Mr. Chairman, obviously with this kind of testimony, it is a mockery to think that we are going to be able to get into it in 5 minutes. But if the Chair decides to follow through on that——

Mr. **Waxman**. Well, each member is accorded a 5-minute interval for questioning and you have consumed more than that period of time. If you have a few more questions, you can do it briefly but these reports have been around for some time and this is not the first hearing that we have held on the question of the scientific basis for looking at acid rain.

Mr. **Luken**. Is the chairman saying that there is nothing new in the testimony that Mr. Uman just gave?

Mr. **Waxman**. I am just saying that it is not a new issue.

Mr. **Luken**. Then I will let it go at that then that there is nothing new if it is the same old thing.

Mr. **Waxman**. Do you want to pursue some more questions or do you want to argue with me?

Mr. **Luken**. I thought the chairman just cut me off.

Mr. **Waxman**. Do you want to ask some more questions? I wouldn't want to cut you off.

Mr. **Luken**. That was the general idea.

Mr. **Waxman**. Let's go for a few more minutes. The gentlemen, without objection, will be given an additional 2 minutes and then we will conclude.

Mr. **Luken**. Did you say page 6 or page 16?

Mr. **Uman**. Six.

Mr. **Luken**. Page 6.

Mr. **Uman**. On page 6 the 10 principal findings are listed, Nos. 1, 2, 3, 4, 5, 6, 7, and 9 all have to do with aquatics.

Mr. **Luken**. Do they say on pages 6 and 7 where the source of the emissions are for the damage in eastern North America?

Mr. **Uman**. The sources are emissions of sulfur dioxide.

Mr. **Luken**. From where?

Mr. **Uman**. Anthropogenic emissions of sulfur dioxide.

Mr. **Luken**. From where?

Mr. **Uman**. From throughout the area wherever the sources are. We calculated sources on a State-by-State basis.

Mr. **Luken**. In previous reports the NAS found that local sources had a greater impact than long range sources, right?

Mr. **Uman**. One has to qualify that statement, Congressman. If you have two absolutely equivalent sources on a pound-for-pound basis and there are only two of them, the one that is closer to you is more important to you. But we don't have circumstances like that and with the present state of knowledge we can't tell at a given instance the relative importance of sources within say 30 miles or sources within 500 miles of a given site because there are so many sources out there.

Mr. **Luken**. Do you give any weight at all to the idea that the closer the sources the more likely the impact?

Mr. **Uman**. As I indicated, sir, that is correct.

Mr. **Luken**. That is correct?

Mr. **Uman**. That——

Mr. **Luken**. I don't think you indicated that.

Mr. **Uman**. I said that if you have equivalent sources on a pound-for-pound basis, the closer the source the more important it is.

Mr. **Luken**. What about the statement in the NAS previous reports that indicated that anything over 1,000 kilometers could not make any judgment at all? Isn't that correct?

Mr. **Uman**. The previous reports said that the emissions over broad areas of the order of 1,000 kilometers across are thoroughly mixed so you can't distinguish the origins of particular molecules of sulfur dioxide within regions of that size.

Mr. **Waxman**. Let me ask you about the Adirondacks.

Mr. **Luken**. I think he was in the middle of a sentence, Mr. Chairman.

Mr. **Waxman**. Are you in the middle of a sentence?

Mr. **Uman**. I had finished my sentence.

Mr. **Waxman**. I am sorry. I would not have wanted to interrupt you.

Mr. **Luken**. I certainly detected he was in the middle of a sentence but apparently we are not on the same wave length there.

Mr. **Waxman**. How about the Adirondacks? That is an area that seems to be very sensitive. Is there a local source in the Adirondacks, a major local source, in the Adirondacks that is causing the problem?

Mr. **Uman**. The most recent study did not look into the question of source receptor relationships. The Calvert Study in 1983 did and in that study they determined that the principal sources for deposition in the Adirondacks based on wind rose measurements were to the sectors to the southwest of the Adirondacks which means western New York, western Pennsylvania, Ohio, Indiana, and West Virginia, that part of the country, and to the northwest which is southern Ontario.

Mr. **Waxman**. All right. Thank you very much.

Mr. **Luken**. What are the sources for the acidification of the lakes in Florida?

Mr. **Uman**. Well, there are probably several.

Mr. **Waxman**. This will be the last question and I would like you to respond to it.

Mr. **Uman**. We have not studied that in detail but my own judgment would be that some are indigenous to Florida and others are along the industrialized park along the Gulf of Mexico.

Mr. **Luken**. Have you studied it? What do you mean that you haven't studied it in detail? You only studied the Northeast?

Mr. **Uman**. We did not look at wind rose patterns and long range transport as it affects Florida.

Mr. **Luken**. Why on earth would you only look at the lakes in the Adirondacks?

Mr. **Waxman**. Mr. Luken, I am going to have to——

Mr. **Luken**. Well, he has just impeached his whole testimony. He said that he only looked at the lakes in the Adirondacks and he is coming to conclusions. He is willing to offer opinions on Florida on his best judgment——

Mr. **Uman**. I would be happy to respond to that.

Mr. **Luken**. Which he admits is not based upon——

Mr. **Waxman**. We will hold the record open for a response but we have to conclude this meeting now and I am sorry. We have had enough opportunity for questions and answers.

Gentlemen, thank you very much for being with us and we will look forward to any further response you want to make, Dr. Uman, for that point.

We stand adjourned.

[Whereupon, at 2:20 p.m., the subcommittee recessed to reconvene at the call of the Chair.]

[The following statement and letters were received for the record:]

Written Statement of
Michael P. Walsh

Before The
Subcommittee On Health and the Environment
of the
House Committee on Energy and Commerce

May 8, 1986

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My name is Michael P. Walsh and I am an independent technical consultant in the motor vehicle air pollution control field. My clients have included many government agencies as well as private companies engaged in the manufacture of pollution control devices. Most recently, I have been a consultant to the Senate Environment and Public Works Committee in the development of its recent acid rain control bill which includes a tightening of passenger car standards among other items.

From 1974 to 1981 I was employed by the U.S. Environmental Protection Agency; during the last three of those years, I was the Director of the Office of Mobile Source Air Pollution Control.

I am presenting this statement as a private citizen, not as a representative of any government agency or company.

I would like to make two points:

1. NOx plays a role in a variety of serious and probably long term environmental problems and should be reduced to the maximum degree feasible;

2. Passenger car and truck NOx control to the degree proposed in HR 4567 is feasible and, in some cases, is actually being achieved by many individual vehicles today.

I would now like to elaborate on each of these points, considering the bill section by section.

Title II Provisions in House Acid Rain Bill of 1986

I. Section 201 (g). NOx Emissions

Vehicle Type	Model Year	Standard
Passenger Cars	1989 and later	0.7 gpm
Gasoline Trucks up to 8500 lbs	1988 and later	1.2 gpm
Gasoline Trucks 8500-14000 lbs	1988 and later	1.7 g/BHP-hr
Diesel Trucks up to 6000 lbs.	1988 and later	1.2 gpm
Diesel Trucks 6-8500 lbs.	1988 and later	1.7 gpm

In discussing these provisions, several arguments have been raised in opposition, which are summarized below.

II. Need

Opponents argue that further mobile source NOx control is not needed because NOx is not a major contributor to acid rain, most of the country is in attainment for NO_2, and NOx control will actually make the ozone problem worse. These arguments are in error as will be explained below.

Nitrogen oxides are a by-product of most combustion processes; in urban areas, usually from 30 to 50 percent is emitted by motor vehicles. As a class of compounds, the oxides of nitrogen are involved in a host of environmental concerns impacting adversely on human health and welfare.

A. Acid Deposition

Acid deposition reduces visibility, and in sensitive aquatic systems such as small lakes and streams can destroy fish and other forms of life.[1-5] More and more evidence shows that forests are increasingly at risk as well.[6,7] (For a more detailed discussion, see Attachment 1.)

Acid deposition results from the chemical transformation and transport of sulfur dioxide and nitrogen oxides.[8,9] The major strategy for addressing the acid rain problem should be reductions of sulfur emissions; however NOx controls are important and will be increasingly so over the next ten to fifteen years.[10-14] There are several reasons:

1. NOx emissions are responsible for about one third of the acidity in rainfall.
2. While emissions of SOx are expected to stabilize or hopefully even decline in the future, NOx emissions are projected to increase dramatically. In fact, the 1981 NAS Report indicated that NOx emissions could exceed sulfur emissions by the end of the century.
3. Under certain circumstances, such as the Spring snow melt, nitric acid is disproportionately responsible for fish kills in lakes and streams.

At the 1982 International Conference on Acidification of the Environment in Stockholm, it was concluded that the "acidification problem is serious and, even if deposition remains stable, deterioration of soil and water will continue and may increase unless additional control measures are implemented and existing control policies are strengthened."[2] Therefore, the assembled experts from around the world continued, "we know enough to be able to say:

> Unless we reduce our emissions of sulfur and nitrogen oxides, more lakes and streams, more groundwater, more

> soils and forests will become acidified and we will be adding to the economic and aesthetic damage we have already done...Best available technology which is economically feasible should also be applied to reduce NOx emissions from both stationary and mobile sources."

This conclusion was reinforced during the International Conference of Ministers on Acid Rain which took place in Ottawa, Canada during March of 1985. The final declaration of the 10 participating countries commits each to "take measures to decrease effectively the total annual emissions of nitrogen oxides from stationary and mobile sources as soon as possible and at the latest by 1993."[15]

B. Direct Health Effects

Nitrogen dioxide (NO_2) is linked with increased susceptibility to respiratory infection, increased airway resistance in asthmatics, and decreased pulmonary function.[16,17] Even short term exposures to NO_2 have resulted in a wide ranging group of respiratory problems in school children - cough, runny nose and sore throat are among the most common - as well as increased sensitivity to bronchoconstrictors by asthmatics.[18,19]

The World Health Organization concluded that a maximum 1 hour exposure of 190-320 micrograms per cubic meter (0.10-0.17 ppm) should be consistent with the protection of public health and that this exposure should not be exceeded more than once per month.[20] The State of California has also adopted a short term NO_2 standard, 0.25 ppm averaged over one hour, to protect public health.[21]

C. Photochemical Oxidants (Ozone)

The most widespread air pollution problem in areas with temperate climates is ozone, one of the photochemical oxidants which results from the reaction of nitrogen oxides and hydrocarbons in the presence of sunlight. Motor vehicles are a major source of both of these precursor pollutants.

Adverse health consequences associated with exposure to elevated levels of ozone include eye irritation, cough and chest discomfort, headaches, upper respiratory illness, increased asthma attacks and reduced pulmonary function.[22-27] Recent data indicates adverse health effects at or below the current air quality standard.[28] Even with this standard, almost 80 million Americans currently reside in areas which violate it.[29]

Numerous studies have also demonstrated that photochemical pollutants seriously impair the growth of certain crops. For example, the Congressional Research Service of the U.S. Library of Congress found that, in the United States alone, "the short-run or immediate impacts of ozone are evident in annual crop yield decreases estimated at $1.9 to $4.3 billion."[30] In the longer term, CRS points out that "ozone damage has resulted in disappearance of high yielding crops from localities and even from the genetic base." Other negative impacts include seed yield reduction of 10 to 22 percent in field corn, up to 33 percent reductions in wheat yields and from 24 to 50 percent reductions in soybean yields.[31,32]

Just recently, the President of Weyerhaeuser noted that "Growth chamber tests show that ozone in excess of 500 parts per billion will cause visible damage to trees and other crops within a matter of hours. Experience in the San Bernardino National Forest, near Los Angeles, indicates that consistent levels of ozone in the range of 200 to 300 parts per billion will cause visible damage within the growing season, and in ten years of successive Summer exposure will kill Ponderosa pine trees." He expresses even greater concern with other results which indicate "a linear reduction in net photosynthesis - and thus in growth - with no visible damage, when ozone is in the range of 30 to 80 parts per billion."[33]

D. NOx Control Is Necessary To Clean Up Ozone

Photochemical smog results from chemical reactions involving both hydrocarbons and nitrogen oxides in the presence of sunlight. While historically the major strategy for reducing smog has focused on tight restrictions on hydrocarbon emissions, NOx control is also necessary, particularly with regard to the highest and, therefore, most hazardous levels. This conclusion was verified by a panel of experts convened by the National Commission on Air Quality (NCAQ), which found that, "NOx control as well as HC control is needed."[34]

1. The most severe air pollution periods consist of multi day episodes during which NOx and other smog precursors have long periods of time to interact; under such conditions, even higher ozone values would result if more NOx were emitted because there would be "a high degree of day to day carryover of such key pollutants as NO_2, peroxyacetyl nitrate (PAN), formaldehyde (HCHO) and higher aldehydes, and nitrous acid (HONO)."[35] These pollutants "are the major early morning sources of hydroxyl radicals (OH) which drive the oxidation processes involved in photochemical smog."[35]

2. Along with ozone, a wide spectrum of hazardous components tends to be associated with photochemical smog episodes. The NCAQ expert panel also expressed concern that higher NOx emission rates would lead to higher ambient concentrations "of other nitrogen

bearing pollutants, e.g., NO_2, nitric acid, peroxyacetyl nitrate (PAN), and other nitrates." These latter compounds are traditionally associated with ozone as part of the photochemical smog family.

3. NOx control will also reduce ozone concentrations downwind in transport situations; since many densely populated areas of the United States are "downwind" of other urban centers, NOx and HC control seems the only reasonable course of action to protect public health.

As pointed out by the California Air Resources Board in a study which supported that state's adoption of a 0.4 gpm NOx standard for passenger cars, light duty trucks and medium duty vehicles, "Since 1978, a period during which both HC and NOx emissions have decreased, daily peak smog season ozone levels have declined significantly in both the central and eastern portions of the basin. It is in these areas that ozone concentrations are the highest and affect the health of both sensitive and healthy individuals."[36]

E. Other

While nitrogen dioxide alone does not significantly reduce visual range, it is responsible for a portion of the brownish coloration observed in polluted air. In addition, nitrogen dioxide and particulate nitrates also contribute to pollutant haze.

Oxides of nitrogen have also been shown to effect vegetation adversely. This effect is even more pronounced when nitrogen dioxide and sulfur dioxide occur simultaneously. Further, nitrogen dioxide has been found to cause deleterious effects on a wide variety of textile dyes and fabrics, plastics and rubber.

In the face of (a) an annual average nitrogen dioxide air quality picture which probably will worsen over the next two decades even with tight automobile nitrogen oxides controls, (b) a growing consensus that short term nitrogen dioxide levels which tend to be dominated by mobile sources may be even more of a health concern than annual average exposures, (c) the negative role of nitrogen oxides in contributing to the photochemical oxidant problem, (d) the impact of nitrogen oxides on visibility and (e) the emerging concern with acid deposition and the growing awareness of the role which nitrogen oxides plays in its formation, the only reasonable conclusion seems to be that nitrogen oxides control to the level of technological feasibility is warranted. This conclusion was reinforced by the latest EPA air quality and emissions trends report which shows that national nitrogen oxide emissions increased by 600,000 metric tons from 1983 to 1984; from transportation sources alone, it increased by about 100,000 tons.[29]

III. Feasibility

Opponents of this bill argue that even if the standards were needed, they are not technologically feasible. This argument seems particularly suspect in that many vehicles already achieve these levels; for most others, either EPA or California have adopted the requirement after finding that they are technologically feasible. In a few cases, while not adopted by either EPA or California, they have found them to be feasible. Each specific standard will be discussed below.

IV. Passenger Cars 0.7 gpm NOx by 1989.

Passenger car and light truck NOx control to the degree recommended in the Bill is feasible and is actually being achieved by many individual vehicles today. Even if one accepts the manufacturers arguments that they must certify well below the standard if they are to actually achieve the standards in use (an argument that runs counter to the fact that many engine families are introduced into production each year even though their certification levels are very close to the actual standards), the attached (Attachment 2) figure illustrates the distribution of current cars which are currently certified below 0.4 grams per mile based on the 1986 EPA and CARB certification data. It clearly shows that NOx levels of 0.7 or even lower are currently achievable. For example, of 576 engine families certified, over 300 were at or below 0.4 NOx, and this is without any requirement that they achieve this low level. Over 175 were below 0.25 NOx; almost 150 simultaneously below 0.25 HC and 0.25 NOx.

Just within the last few weeks, the California Air Resources Board determined that 0.4 NOx for passenger cars was necessary and feasible and cost effective. (see Attachment 3)

With regard to the incremental costs of adopting 0.7, they should be very low. First, as indicated above, many vehicles already achieve the necessary levels and will not need any additional technology. For many others, slight calibration changes should be sufficient. Only a few vehicles will need to increase the rhodium loadings on their catalysts. Based on a range of projected rhodium costs of $950 to $1900 per troy ounce, as recently estimated by CARB, the cost of a catalyst will increase from $15 to $30 per vehicle. Additional certification costs are estimated to be at most $5 per vehicle. Therefore, I estimate that at most about 50% of the vehicles would have increased costs of about 20 to $35 per vehicle. Averaged over the entire fleet, this would add an additional $10 to $17.50 per vehicle at most.

No fuel economy penalty or improvement should be associated with this action.

V. Gasoline Trucks up to 8500 lbs, 1.2 gpm NOx

Passenger cars, both gasoline and diesel, currently achieve a NOx standard of 1.0 grams per mile. Light trucks are in most characteristics very similar if not identical to cars; therefore, they should be able to apply the same technology. Conceding that the heavier light trucks, however, between 6000 and 8500 lbs., may have a slightly more difficult time achieving these levels because of their higher load carrying capacity, EPA determined that a standard of 1.2 would be roughly equivalent to a 1.0 gram per mile passenger car standard, for even the heavier trucks in this category. (see page 80 of 1981 Reg analysis, Attachment 4) In fact, EPA determined in 1981 that a standard of 0.9 would be technologically feasible by 1985 for these vehicles, both gasoline and diesel, despite the full life useful life requirements. (Attachment 5)

In commenting on EPA's 1984 proposal of 1.2 grams per mile for light duty gasoline trucks under 6000 lbs., Chrysler, Ford, General Motors, Nissan and Toyota agreed that the standards were technologically feasible. While EPA also concluded (again) that the 1.2 standard is feasible also for gasoline trucks between 6000 and 8500 lbs., EPA decided that the same standard should be proposed as for diesel trucks in this same weight range and therefore only proposed and subsequently adopted 1.7.

Of 241 gasoline fueled light trucks certified for 1986, 72% or 173 already certify to 1.2 or below. Over 160, or 67%, certified to a level of 0.9 or below.

EPA estimated that all vehicles would convert to three way closed loop technology from only 51.8% in 1985. Of the remainder, 4.9% have three way open loop systems at present and 43.3 have only oxidation catalysts. For light duty gasoline trucks under 6000 lbs. GVW, EPA estimated a hardware cost increase of 58$ per vehicle in the fleet to make these conversions. For the heavier light duty gas trucks, those over 6000 lbs GVW, the hardware cost increase would be about 35$ per vehicle. Because so many manufacturers have already applied much of this technology to their vehicles, EPA correctly concluded that there are other benefits -- including improved fuel economy and driveability and better parts consistency with their light duty vehicles. Therefore EPA applied 50% of the costs to the standards and 50% to the other benefits leaving the per vehicle costs at 29$ for the light trucks under 6000 lbs and 18$ for those over 6000 lbs. (see Attachment 6)

These standards should improve fuel economy. As noted by EPA, "LDGT's which are already equipped with three way catalyst technology will experience little or no reduction in fuel economy while those LDGT's which are converted from oxidation to three way technology are expected to experience increases in fuel economy." While not taking "credit" for these gains in its regulatory analysis, EPA determined based on an analysis of matched pairs of Federal (lenient standards) and California (stringent standards) vehicles that the gain could be as high as 8%.(see Attachment 7, 2-18 from RA) Since EPA further estimated that fuel economy improvements of only 1% would improve lifetime operating costs by 51$, it seems clear that adoption of these standards should not only lower air pollution but do so at an overall savings to consumers.

VI. Diesel Trucks up to 8500 lbs., 1.2 & 1.7 gpm

In its March 15, 1985 rule, EPA adopted these standards for light duty diesel trucks, concluding that they were feasible and cost effective. In fact, according to the EPA Regulatory Analysis, Ford Motor Company agreed that 1.7 was feasible.(see Attachment 7)

The costs of these standards were estimated by EPA to average only 21$ per light duty diesel truck under 6000 lbs and 44$ per truck over 6000 lbs. EPA further concluded that there would be no measurable change in fuel economy resulting from the NOx standards.

VII. Gasoline Trucks 8500-14000 lbs, 1.7 g/BHP-hr

Many medium trucks (8500-14,000 lbs. GVW) are still gasoline fueled and these will need to be equipped with oxidation catalysts by 1987 to achieve the HC and CO standards. Adoption of a 1.7 standard will require the use of the already proven 3-way catalyst technology to these engines instead of oxidation catalysts. As noted by EPA in 1981, "It is the staffs judgement that achievement of the full 75 percent reduction, i.e., a reduction to the level of the 1.01 g/BHP-hr emission target level, is technologically feasible through the application of three way catalyst technology, and certainly if used in conjunction with oxidation catalysts to maintain the 90 percent HC and CO reductions. Additional NOx control, if necessary, could also be provided by EGR." (see page 59 of 1981 Reg Analysis, Attachment 8)

It is important to note that any engines unable to achieve the 1.7 level this quickly could still be sold with non conformance penalties. The alternative of setting the standard at the level diesels can achieve is inconsistent with the health and welfare need for maximum feasible NOx control and with the concept of basing standards on the level achieved by the technological leader not the technological laggard. This philosophy has guided the nation in forcing technological developments for HC, CO, NOx and particulates from cars. If we have learned only one thing from the Clean Air Act, it should be that greatest progress occurs when stringent standards with firm deadlines are adopted.

VIII. Section 201 (h) HC Standards for Light Trucks

Vehicle Type	Model Year	Standard
Trucks up to 6000 lbs.	1990 and later	0.41 gpm
Trucks 6-8500 lbs.	1990 and later	0.53 gpm

Passenger cars, both gasoline and diesel, currently achieve a HC standard of 0.41 grams per mile. Light trucks are in most characteristics very similar if not identical to cars; therefore, they should be able to apply the same technology. Conceding that the heavier light trucks, however, between 6000 and 8500 lbs., may have a slightly more difficult time achieving these levels because of their higher load carrying capacity, a standard of 0.53 would be roughly equivalent to a 0.41 gram per mile passenger car standard, for even the heavier trucks in this category.

A review of the latest certification data indicates that technological feasibility should not be a problem. in fact, over 70% of all light truck models certified for 1986 (184 of 261 engine families) certified at or below 0.41. This encompassed vehicles from all size and weight categories and included both gasoline and diesel fueled. Over 50% certified below 0.3 grams per mile.

California has in fact required a portion of the light trucks in both GVW categories to achieve standards below those required in this bill for many years (see Attachment 9).

One significant distinction between California and Federal standards and between Federal light truck standards and Federal auto standards is the requirement that Federal light trucks achieve standards for the full life of the vehicle. However, the difficulty of extending the useful life has been found by EPA to be relatively minor. For example, to improve catalyst durability, manufacturers are only required to improve the quality of the metal used to support the system and to increase the size and metal loading of the catalyst. Most of these costs are already accounted for in the initial design of Federal light trucks achieving the current more relaxed light truck standard over the full vehicle life.

IX. Section 211 (h) Regulation of Sulfur in Diesel Fuel

This modification would limit the sulfur content of any motor vehicle diesel fuel to a maximum of 0.05 percent by weight by January 1, 1989.

Just recently the issue of reducing sulfur in diesel fuel was analyzed by a contractor for EPA and it is appropriate to summarize some of the conclusions here:

1. Reducing fuel sulfur would reduce SO_2 emissions and the sulfate fraction of diesel particulates, and would indirectly reduce ambient levels of sulfate particles and acid deposition.
2. It is feasible to reduce the sulfur from current levels of about 0.3% to 0.05% without reducing fuel availability or refinery modification.
3. Some reduction in diesel fuel aromatic content would tend to result automatically from the changes introduced to reduce diesel fuel sulfur.
4. Based on limited data, it appears that the maintenance savings due to the sulfur reduction would be about four times the increased refining costs needed to bring it about.

For complete description of the study see Attachment 10.

California has already adopted regulations requiring low sulfur diesel fuel (0.05%) in the South Coast Air Quality Management District.

I hope this information is helpful to the Subcommittee. Please don't hesitate to contact me if I can be of any further assistance.

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Attachment 1

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Motor Vehicles and Long Range Transport of Pollutants—A Growing Global Problem

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Government/Industry Meeting
& Exposition
Washington, D.C.
May 20–23, 1985

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ISSN 0148-7191

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Printed in U.S.A.

851209

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and Public Works
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Technical Consultant

ABSTRACT

Motor vehicles account directly for up to one-sixth of the total H-ion deposition in the Eastern United States and substantially more in the West. Vehicular pollutants may also play an important catalytic and synergistic role in acidic deposition. In addition, however, motor vehicles clearly cause or contribute in a major way to ozone, hydrocarbons, lead, total nitrogen and other transported air pollutants. It is increasingly clear that whether the goal is to reduce acid rain specifically or transported air pollutants generally, increased control of motor vehicle emissions is important and perhaps essential.

Motor Vehicles Emit significant quantities of pollutants thought until recently to pose principally local threats to health and the environment. But over the last two years evidence increasingly suggests that some of the most severe impacts of vehicular pollution may be removed from the sources both in time and distance. These pollutants are part of the phenomenon popularly called "acid rain".

Acid rain is a term which has been in general use since the mid 1970's.(1) Initially, the term described the conversion of oxides of sulphur and nitrogen into acids which damaged materials, altered sensitive lakes and streams and, possibly, soils and forestsas well. Early descriptions tended to discount the role of vehicular pollutants, first, because sulphur was believed to account for two-thirds of the hydrogen ion deposition versus only one-third from nitrogen and, second, because motor vehicles represented only one-half of total nitrogen based pollution. Thus, motor vehicles were said by some to contribute, at most, one-sixth of the total H-ion deposition.

Starting in about 1982, however, investigators began an intensive search for possible causes of the extensive forest decline and die-back which has occurred simultaneously in both Europe and North America. Early hypotheses continued to focus on sulphur-based "acid rain". Over time, the record clearly established the need for sulphur reductions. But more recent research suggests that although sulphuric acid and sulphate are important causes of forest damage, in some cases, other pollutants may be of equal or perhaps even greater importance. These other pollutants include ozone, oxides of nitrogen, hydrocarbons, lead and other heavy metals. Moreover, attention on oxides of nitrogen has shifted from their potential role as an acidic compound to their possible effect as a fertilizer. Nitrogen was discounted by some early in the forest damage debate because it was said to be a fertilizer and, hence, beneficial. But nitrogen is now being suggested as having over

0148-7191/85/0620-1209$02.50
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fertilized forests, thus contributing to their decline.

The term "acid rain" continues to be used to describe both the damages caused by acidic deposition and those caused by the mix of other air pollutants. This misuse of the term is inaccurate and tends to obscure the role which motor vehicles play in both problems. As to acidic deposition, motor vehicles account directly for up to one-sixth of the total H-ion deposition in the Eastern United States and substantially more in the West. Vehicular pollutants may also play an important catalytic and synergistic role in acidic deposition. Without regard to the substantiality of their role in acidic deposition, however, motor vehicles clearly cause or contribute in a major way to ozone, hydrocarbons, lead, total nitrogen and other transported air pollutants.

In the past two years, there have been important shifts in and additions to the knowledge base regarding acidic deposition and transported air pollutants. These force earlier estimates of the role played by motor vehicles in acid rain and transported air pollution to be revised. It is increasingly clear that whether the goal is to reduce acid rain specifically or transported air pollutants generally, increased control of motor vehicle emissions is important and perhaps essential.

HISTORICAL BACKGROUND

Acid rain is a unique pollution phenomenon in several respects:

First, it presents the only instance to date in which there is convincing evidence that anthropogenic pollution has altered the environment on a continental scale. There have been predictions that carbon dioxide emissions could increase the earth's atmospheric temperature through the "greenhouse effect".(2) There also have been predictions that the stratospheric ozone layer would be destroyed to some degree by emissions of chloroflorocarbons.(3) But only in the case of acid rain is there clear and measured evidence that pollution is resulting in asub-continental or continental alteration of the basic environment.

Secondly, it is one of the few instances where public opinion has been mobilized on the basis of damage to the environment, rather than public health.

Finally, until recently acid rain was one of the few air pollution problems which did not appear to involve in a substantial way the motor vehicle. Recent developments, however, suggest that the control of vehicle emissions will increasingly be a major element of any program aimed at coping with the complex set of problems caused by either "acid rain" or other transported air pollutants.

"Acid rain" is the popular term for the transformation in the atmosphere, and their subsequent deposition, of oxides of sulphur and nitrogen into sulfate and nitrate.(4) Until roughly the last two years, most public attention in the United States focused on the impact which acid deposition was asserted to be having on aquatic ecosystems, especially in the Northeast.(5) Within the last two years, however, attention has focused increasingly on significant and simultaneous die-back and declines in forests in both the United States and Europe.(6)

In the context of aquatic damage, researchers and policy makers were inclined to restrict themselves to an examination of primarily oxides of sulphur, paying relatively less attention to the role played by oxides of nitrogen. One paper presented to a 1984 meeting of the Air Pollution Control Association explained as follows:

> Detailed watershed studies had shown that both nitrate and ammonia don't contribute to long term acidification of the water since they are taken up by vegetation and do not accumulate in surface waters; therefore, reduction of sulfate deposition will reduce long term acidification of surface waters. While nitrate and ammonia affect the pH of rainfall, they have much less

> or no effect on surface water acidification... Therefore, it was concluded by the working group that sulfate was the dominant anion in both long and short term acidification and must receive priority for control.(7)

The theories which explained aquatic damage by focusing on sulfate did not explain forest damage as well, however.(6) Beginning in 1982, forest damage was increasingly reported both in Europe and the United States. A report issued in 1982 by a Committee of the United States Senate stated the following:

> In the United States, there have been widespread, substantial and sustained decreases during the past two to three decades of red spruce and pitch pine. Unfavorable changes in tree growth have also occurred in Europe since 1950.(8)

During the following two years, reports of forest damage became increasingly common, both in the United States and Europe, with the government of West Germany estimating that 50 percent of its forested areas were damaged.(9) In the past year, reports of forest damages attributed to air pollution have become more common in the United States. The National Park Service has reported forest or biosphere damage in the Acadia, Shenandoah and Great Smoky National Parks as well as Saquaro National Monument and numerous other protected areas.(10) A careful examination of tree rings indicates that the dramatic decline started about 1960.(11)

Increasingly, it appeared that pollutants other than the oxides of sulphur were possibly responsible, and that the source of a major portion of these was the automobile. This culminated in a recent report by a committee of the National Governors Association which made the following observation:

> It appears that the combination of sulphur dioxide and nitrogen oxides is directly linked to forest damage. On some sites, such as in areas of the Federal Republic near the Czechoslovakian border, it appears that sulphur dioxide may be the key pollutant. On other sites, nitrogen oxides and ozone appear to be the more significant factors, although in no case is the research evidence conclusive in the sense of establishing a definitive cause-effect relationship. The German experience does appear, however, to raise the relative importance of nitrogen oxides in the forest decline/acid rain debate. In contrast, ozone has not been a factor in the U.S. debate on acid rain and nitrogen dioxide has basically taken the proverbial "back seat" to concerns over sulphur dioxide emissions in the U.S..(12)

Since motor vehicles represent a major source of both oxides of nitrogen and hydrocarbons -- and hence ozone -- controls of their emissions have become an increasingly important element in the debate over acid rain. And the debate itself is becoming increasingly urgent politically as scientists and politicians begin to refer to the environmental damage as a "plague"(6) a "Mounting Menace"(13) and "the key to the 1987 national (the Federal Republic of Germany) elections."(12)

THE ROLE OF THE MOTOR VEHICLE POLLUTANTS

Motor vehicles account, directly or indirectly, for a large share of the pollutants which cause the damages ascribed to "acid rain", although the precise magnitude has not yet been determined. Several studies have estimated the role of motor vehicles in the acid rain problem by focusing almost solely on the NOx contribution.(14-18) Ford of Europe concluded that the automotive contribution to acid rain in the United Kingdom is approximately 7%. In the U.S., Ford found that "The maximum contribution of passenger cars to the acidity of wet precipitation in the NorthEastern United States is about 6% of the total acidity." For California, however, "the maximum

- 4

average contribution of passenger cars is about 19%." A Motor Vehicle Manufacturers Association study concluded that motor vehicles could account for about 10.5%, 4.5% from passenger car NOx, 4.5% from truck and bus NOx and 1.5% from truck and bus sulphur emissions. Another study found that "automobile emissions may be contributing 5 to 8.5% directly to environmental acidification." The authors continued that the entire transportation sector emissions may contribute from 13 to 22%.

While this direct NOx impact alone is significant, from 7 to 22%, it tends to significantly understate the overall motor vehicle role. For example, when ozone is also considered, the motor vehicle is even more important. In the United States, transportation sources are responsible for 40% of nationwide NOx emissions and 34% of volatile organic compounds (VOC), the two major precursors of photochemical smog.(19) To fully appreciate the significance of motor vehicles when assessing the causes of "acid rain", it is necessary to understand the various mechanisms which are at work.

OXIDES OF NITROGEN - NOx emissions account for one-third of acid deposition in the Eastern United States, compared to two-thirds for sulphur dioxide, but in the Western U.S., oxides of nitrogen are the major contributors to acidic deposition.(20) As the Congressional Office of Technology Assessment (OTA) noted in its recent analysis, "In the West, nitrogen compounds may contribute as much or more to precipitation acidity as sulphur."(20) In addition, under certain conditions such as during the Spring thaw when snowfall accumulated over the winter melts, the NOx impact can be much higher. Another study by the World Resources Institute noted that "In most large western cities, NOx are the dominant acid-forming emissions. Indeed, vehicular NOx emissions are the largest source of acid precursors in California; they contribute to acidic deposition in the Sierra Nevada and possibly in the Rockies. Seattle-Tacoma and Denver have been implicated as sources of acidic deposition in the Cascades and on the eastern slope of the Rockies, respectively."(21)

In addition to causing damage through their contribution to acidic deposition, oxides of nitrogen have recently been suggested as direct and independent causes of forest injury.

> The increase in available nitrogen in air and precipitation during the last decades has changed the nitrogen conditions in the temperate forests of northern Europe so that the trees have become "over-saturated" with nitrogen; they have grown fast and formed large cells with a high volume, and they are easily attacked by wind, drought and parasites. The inner hormone balance is easily disturbed by this type of nitrogen stress.(6)

A major source of atmospheric nitrogen is combustion, including automobiles. Although nitrogen can also be produced through decomposition or application of fertilizers, "wet and dry deposition of different nitrogen compounds has become the main additional nitrogen source for temperate forests" of Europe.(6)

NOx emissions roughly tripled across the U.S. from 1940 to 1970 and have remained roughly stable since that time, in large part as a result of the relatively aggressive automobile NOx control program adopted in the 1970 Clean Air Act. Motor vehicles are currently the largest source of emissions of oxides of nitrogen, accounting for slightly less than one-half of the United States' total loadings.(20)

NOx increases have not been restrained as well in other parts of the world, however, where auto emissions standards have been less strict. For example, in Western Europe, annual NOx emissions doubled in the 11 years between 1968 and 1979.(22) As illustrated in Table A below, the growth in mobile source NOx played a major role in the overall increase.

Table A
Emissions of NOx From Mobile Sources
Selected European Countries
1000 Tons

Country	1970	1975	1980	Increase 1970 to 1980 In Percent
France	392	489	606	+ 54
Germany	738	891	1473	+ 99
Netherlands	159	197	210	+ 31
Sweden	119	147	144	+ 21
Switzerland	71		118	+ 65

Source: OECD

Emissions of NOx are projected to increase through the century, both in the United States and worldwide. Figure 1 illustrates the growth projected by OTA.

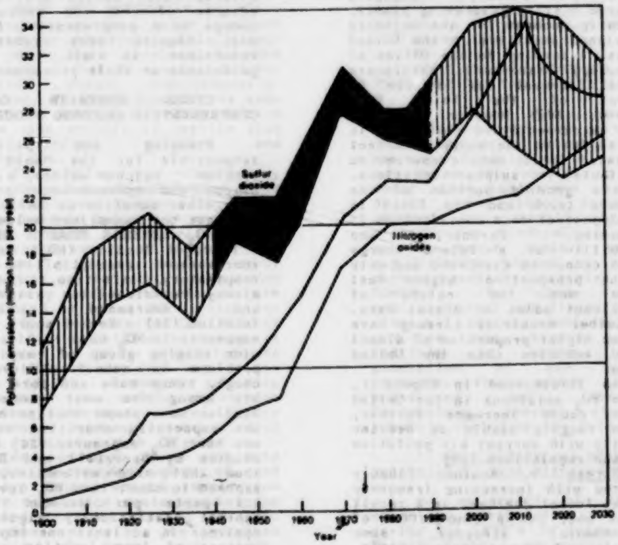

Figure 1
Sulphur Dioxide and Nitrogen Oxides Emissions Trends
in The United States

Table B
Historical Trends in Sulphur Dioxide, Nitrogen Oxides, and Hydrocarbon Emissions (millions of tons, entire U.S.)

Year	Sulphur Dioxide	Nitrogen Oxides	Hydrocarbons
1940	19.1	7.2	15.3
1950	18.1-21.6	7.4-10.3	19.3
1955	17.7	8.5	-
1960	21.2-22.2	11.5-14.0	23.8
1965	26.7	14.2	-
1970	28.7-30.8	17.7-20.4	28.8
1975	27.3-28.2	19.3-21.6	25.1
1980	25.2-26.1	21.0-22.8	24.0-28.3

SULPHUR - Sulphur dioxide emissions increased by about one-third from 1940 to 1970 and have declined slightly since then. Stationary sources, especially electric utility generating plants, presently account for the majority of sulphur emissions in the United States. According to the Office of Technology Assessment, stationary sources account for 90 to 95 percent of the total U.S. emissions.(20) However, because there is currently no limitation in Federal law on the sulphur content of diesel fuels, mobile sources do contribute to sulphur emissions. Since a growing portion of the nation's truck and bus fleet is diesel-powered this contribution is increasing. Further, the possibility of a future energy crisis cannot be dismissed and with it the prospect of higher fuel prices and the return of significant sales of diesel cars. Many other countries already have an even higher proportion of diesel fueled vehicles than the United States.

As illustrated in Figure 1, future SO_2 emissions in the United States could increase further, remain roughly stable or decline slightly with current air pollution laws and regulations.(20)

Stress - Another theory advanced with increasing frequency is that forest die-back is a result of not one, but a combination of environmental stresses, some natural and some anthropogenic, including those outlined above.(33)

More and more it appears that the problems of "acid rain", therefore, are really a family of problems with sulphur dioxide, nitrogen oxides and hydrocarbons playing major roles. In some circumstances, NOx is most important; in others, sulphur derivatives predominate; in still others, ozone causes most of the adverse effects. To reduce the damage in a comprehensive fashion will require very substantial reductions in all of these pollutants or their precursors.

OTHER BENEFITS OF A COMPREHENSIVE CONTROL PROGRAM

Reducing the pollutants responsible for the "acid rain" problem -- sulphur oxides, nitrogen oxides and hydrocarbons -- will have other benefits as well. A few of these are summarized below:

NO_2 ADVERSE HEALTH EFFECTS - Nitrogen dioxide (NO_2) exposure increases susceptibility to respiratory infection, increased airway resistance in asthmatics, and decreased pulmonary function.(34) Even short term exposures to NO_2 have resulted in a wide ranging group of respiratory problems in school children -- cough, runny nose and sore throat are among the most common.(35) Studies have shown that asthmatics are especially sensitive to even one hour NO_2 exposures.(36) Recent studies by Bauer(37) and EPA(38) show that mild asthmatics, when exposed to short-term NO_2 levels of 0.3 parts per million (ppm), exhibit statistically significant declines in at least one important measure of lung function, forced expiratory volume (FEV_1).

The World Health Organization concluded that a maximum 1 hour exposure of 190-320 micrograms per cubic meter (0.10-0.17 ppm) should be consistent with the protection of public health and that this exposure should not be exceeded more than once per month.

PHOTOCHEMICAL OXIDANTS (OZONE) ADVERSE HEALTH EFFECTS - Adverse health consequences associated with exposure to elevated levels of ozone include eye irritation, cough and chest discomfort, headaches, upper respiratory illness, increased asthma attacks and reduced pulmonary function.(39-43)

The World Health Organization recommends that a 1 hour oxidant concentration of 120 micrograms per cubic meter (0.06 ppm) would be the best single value estimate of the exposure limit for oxidants in the ambient air.

CROP AND MATERIALS DAMAGE - Nitrogen oxides also affect vegetation adversely. This effect is even more pronounced when nitrogen dioxide and sulphur dioxide occur simultaneously. Further, nitrogen dioxide has been found to cause deleterious effects on a wide variety of textile dyes and fabrics, plastics and rubber.(34)

The Office of Technology Assessment has estimated that gains in agricultural productivity could range between 2.5 and 24 percent if ozone levels were reduced to background levels of 25 parts per billion. Gains would vary, depending on the crop, but based on 1978 crop prices the losses are estimated at about $2 billion per year.(20) Research on the effects of acidic deposition on crops is currently at about the stage as ozone effects research was in the late 1960's. Research to date indicates that acidic deposition results primarily in visible injury to crops, although some studies have reported growth effects.

Because both ozone and acid deposition blanket much of the Eastern United States, crops and other vegetation would commonly be exposed to both. Little research has been done on the combined effects of ozone and acids. However, according to the Office of Technology Assessment, one researcher has reported "a significant growth reduction in plants intermittently exposed to ozone in addition to receiving four weekly exposures to rainfall of pH 4.0."(20)

VISIBILITY IMPAIRMENT - Major areas of the United States suffer seriously degraded visibility as a result of air pollution. The bulk of visibility degradation is due to light scattering. The most efficient scattering particles are between 0.1 and 2.0 micrograms in diameter; sulfates and nitrates exist in the atmosphere in sizes ranging between 0.1 and 1.0 micrograms. In the Eastern United States, sulfates account for about 50 percent of the visibility reduction annually, and up to 70 percent in the summertime. The principal impact of nitrate is plume blight (e.g. discoloration), but in some areas, it can account for 20 to 25 percent of the light scattering.(20)

WHAT CAN BE DONE TO FURTHER REDUCE MOTOR VEHICLE EMISSIONS?

A great deal has been accomplished over the last decade in reducing emissions from passenger cars in the United States and Japan. No one can seriously doubt that emissions per mile driven have been dramatically reduced. As a result significant progress has occurred in reducing certain motor vehicle problems, e.g., those related to lead and carbon monoxide in center cities. However, the above analysis indicates that additional controls from all sources including motor vehicles are needed wherever feasible to address today's generation of air pollution problems, those which are most widespread and intractable. Fortunately, several steps are possible including the following:

1. More widespread adoption of current U.S. auto standards.

As a result of stringent emissions regulations adopted during the 1970's in Japan and the United States, emissions control technologies for gasoline fueled automobiles have been developed which substantially reduce carbon monoxide, hydrocarbons, nitrogen oxides and lead while simultaneously achieving good performance and fuel economy. Increasingly the world community has been taking advantage of these developments, e.g., the recent decision by Canada to adopt U.S. standards for the 1988 Model Year. However, it seems ironic that an area of the world, Europe, which has been in the forefront in identifying the problems of acid rain and transported air pollutants has also been very slow in adopting the controls. This is doubly ironic since many European manufactured cars are equipped with advanced emissions controls for the U.S. market. While there has been recent progress in this area, the pace seems extremely slow in light of the magnitude of the apparent and perceived problems. If Europe seriously wants to reduce its transported air pollutant problems it should, therefore, require U.S. equivalent standards for all vehicles before the end of this decade.

2. Reconsideration of 0.4 NOx Standard

While significant NOx control has occurred in the case of automobiles, it is clear that further control is possible without further technological breakthroughs. For example, gasoline powered cars in California are already required to achieve a more stringent NOx standard than the rest of the United States -- 0.7 grams per mile compared to 1.0. California has determined that about 41 percent of the projected new car sales during a recent model year would meet a standard of 0.4 grams per mile, which is the statutory standard originally adopted by the Congress in 1970. The California Air Resources Board has estimated that the remaining California cars could be brought into compliance with a 0.4 standard with average sticker price increases of $33 per car with no fuel economy penalty.(44)

In the United States, in light of the new concerns with NOX and the clear feasibility of control, consideration should be given to revisiting the 0.4 gram per mile standard.

3. More Stringent Truck And Bus Controls in the U.S.

With regard to heavy duty trucks and buses, there is great potential for additional control. The recently adopted standards by EPA in the U.S. should be looked upon as a start rather than as a finishing point. Since recent data indicates that methanol fueled trucks and buses have achieved very low NOx (as well as particulate) levels this is an area which is ripe for further efforts.

4. Adoption of State of the Art Truck and Bus Controls Around the World

In the meantime, Japan, Canada and the countries of Europe should consider the same start to control of trucks and buses as has recently been adopted in the U.S.. Truck and bus emissions are clearly already significant and growing. The time for action is now.

5. Reduced Evaporative Hydrocarbons

The major strategy for reducing hydrocarbons from gasoline fueled vehicles has focused on exhaust emissions. Unfortunately, evaporative hydrocarbon emissions are also significant and have not been decreasing as rapidly as anticipated as shown in Figure 2.

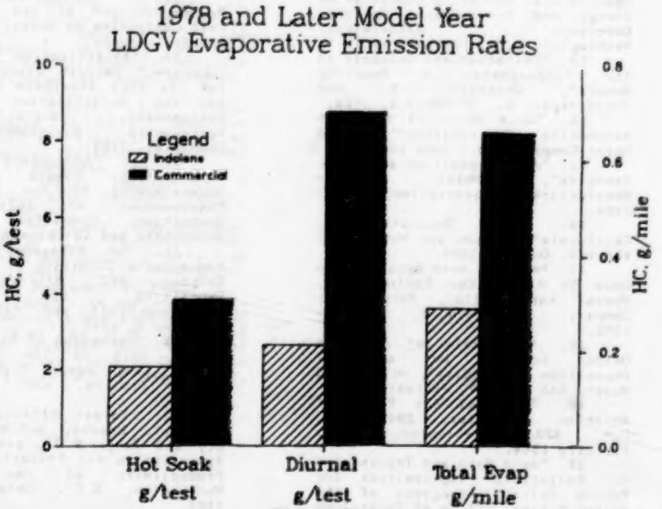

Figure 2

For many late model cars, evaporative hydrocarbons may be as important as exhaust hydrocarbons. A major reason for this increase is the increased volatility of gasoline. Use of indolene, the standard reference test fuel, leads to an evaporative emission rate of about 0.3 grams per mile in late model cars, whereas commercially available fuels results in more than 0.6 grams per mile. Vehicle designs must be modified to accept a wider range of fuels without emitting substantially more hydrocarbons national restrictions should be placed on fuel volatility characteristics or both.

Again, it [illegible] ironic that Europe has so far not taken advantage of even first generation

6. Other Motor Vehicle

Other motor vehicle improvements are also worth reviewing to determine their potential merit. A partial list might include extending the useful life for achieving auto standards to more closely approximate the actual lifetime, more stringent hydrocarbon controls for motorcycles and standards for non highway vehicles or engines.

7. Stationary Source NOx Control

While the focus of this paper has been motor vehicles, it is important to emphasize that stationary source controls are also

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Attachment 2

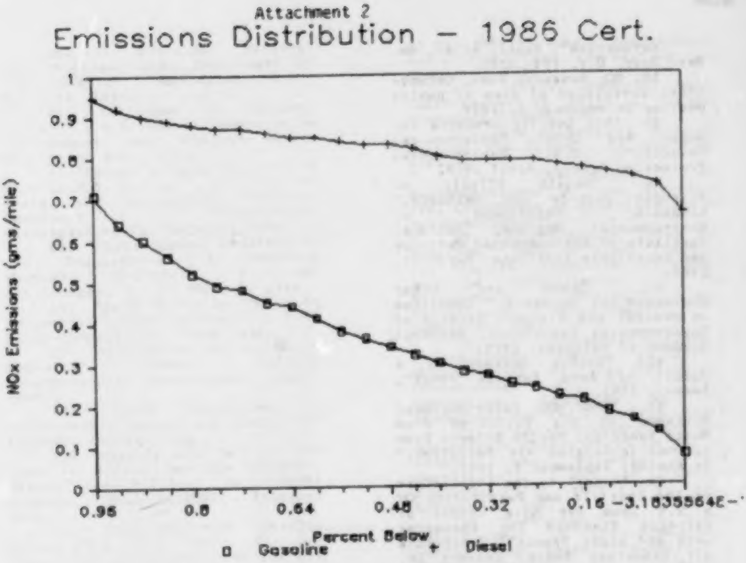

Figure 7

WHEREAS, on January 14, 1983, the Board submitted a report to the Legislature entitled: "Report to the Legislature on the Benefits and Feasibility of a 0.4 gram per mile Oxides of Nitrogen Exhaust Emission Standard for Passenger Cars and Light Trucks";

WHEREAS, the staff has proposed amendments to Section 1960.1.5, Title 13, California Administrative Code, which would restrict the use of the existing optional 0.7 g/mi NOx exhaust emission standard for passenger cars and replace the existing optional 1.0 g/mi NOx 50,000 mile exhaust emission standard for light-duty trucks (0-3999 lbs.) and medium-duty vehicles (0-3999 lbs.) with a limited 0.7 g/mi optional standard;

WHEREAS, the staff has proposed that affected vehicle manufacturers except small volume manufacturers be required to come into compliance with the amended standards over a period of two years beginning with the 1989 model year;

WHEREAS, the Staff has proposed amendments to Section 1960.1, Title 13, California Administrative Code, which would eliminate option 1 of the 100,000 mile emission standards for the 1989 and subsequent model-years, and restrict option 2 of the 100,000 mile emission standards to diesel-powered passenger cars, light-duty trucks (0-3999 lbs.), and medium-duty vehicles (0-3999 lbs.) for the 1989 and subsequent model-years;

WHEREAS, staff has proposed a delay of two years in the compliance schedule for any manufacturer which was subject to "in lieu" standards pursuant to Section 202(b)(1)(B) of the Federal Clean Air Act or which sells not more than 3,000 new motor vehicles per model year in California, i.e., small volume manufacturers;

WHEREAS, the California Environmental Quality Act and Board regulations require that no project having significant adverse environmental impacts be adopted as originally proposed if feasible alternatives or mitigation measures are available which would substantially reduce or avoid such impacts;

WHEREAS, a public hearing and other administrative proceedings have been held in accordance with the provisions of Chapter 3.5 (commencing with Section 11340), Part 1, Division 3, Title 2 of the Government Code;

WHEREAS, the Board finds that:

> The primary exhaust emission standards of 0.39 g/mi non-methane hydrocarbons, 7.0 g/mi carbon monoxide, and 0.4 g/mi NOx for passenger cars and 0.39 g/mi non-methane hydrocarbons, 9.0 g/mi carbon monoxide, and 0.4 g/mi NOx for light-duty trucks and medium-duty vehicles are technologically feasible and cost effective for implementation in 1989 and 1990, except for passenger cars weighing more than 5000 pounds for which compliance with the 0.4 g/mi NOx standard will be technologically feasible and cost effective in 1994;

Staging full implementation of the 0.4 g/mi NOx standard over a period of five years will provide sufficient lead time to enable all affected vehicles to comply with the 0.4 g/mi NOx standard both for certification and in-use;

Some manufacturers may require additional time after initial implementation of the 0.4 g/mi NOx standard to evaluate the durability of emission control systems and make the required changes necessary to achieve 0.4 g/mi NOx in customer use;

Some small volume manufacturers of passenger cars, light-duty trucks, and medium-duty vehicles will require up to two additional years beyond 1989 to develop or buy the technology necessary to meet a 0.4 g/mi NOx emission standard;

Use of the optional 100,000 mile emission standards effective for gasoline-powered 1983 and subsequent model-year vehicles would seriously undermine the effectiveness of the staff's proposal to restrict use of the optional 0.7 g/mi NOx standard.

Retention of option 1 of the 100,000 mile emission standards effective for diesel-powered 1983 and subsequent model-year vehicles is unnecessary because option 1 was generally intended as a gasoline-powered vehicle standard and is not presently utilized to certify diesel-powered vehicles;

As a result of amending the NOx emission standard from 0.7 to 0.4 g/mi, the statutory limit to two years/24,000 miles on warranty coverage for designated emissions control system parts will no longer be operative for vehicles certified to the 0.4 g/mi standard;

WHEREAS, the Board further finds that:

The proposed amendments will result in significant adverse environmental impacts as follows: a slight increase in ozone levels in areas of relatively low ozone levels and a slight decrease in the current rate of reduction of vehicle benzene emissions;

The proposed amendments will result in significant reductions in emissions of NOx, hydrocarbon and carbon monoxide (CO), and concomitant reductions in ozone levels in areas of highest ozone concentrations, reduced CO levels, and reductions in particulate matter, nitrogen dioxide, visibility impairment, and acid deposition;

There are no feasible mitigation measures or alternatives available which would substantially reduce the significant adverse impacts while at the same time providing the substantial overall health benefit realized by the significant reductions described above.

NOW, THEREFORE BE IT RESOLVED, that the Board hereby approves the proposed amendments to Sections 1960.1 and 1960.1.5, Title 13, California Administrative Code as set forth in Attachment A hereto.

BE IT FURTHER RESOLVED, that the Board hereby approves amendments to the "California Exhaust Emission Standards and Test Procedures for 1981 and Subsequent Model Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles" as set forth in Attachment B hereto.

BE IT FURTHER RESOLVED THAT the Board directs the Executive Officer to adopt the amendments to Sections 1960.1 and 1960.1.5, Title 13, California Administrative Code, and the incorporated "California Exhaust Emission Standards and Test Procedures for 1981 and Subsequent Model Passenger Cars, Light-Duty Trucks and Medium-Duty Vehicles," as set forth in Attachments A and B, after making them available to the public for a period of 15 days, provided that the Executive Officer shall consider such written comments as may be submitted during this period, shall make such modifications as may be appropriate in light of the comments received, and shall present the regulations to the Board for further consideration if he determines that this is warranted.

BE IT FURTHER RESOLVED that the Board directs staff to work with the California Automotive Task Force and other interested parties in developing appropriate legislation to reduce warranty coverage on tune-up parts for light-duty vehicles to two years or 24,000 miles whichever occurs first, consistent with preserving the air pollution benefits of the Board's motor vehicle emission control program.

BE IT FURTHER RESOLVED, that the Board hereby determines that the amendments approved herein will not cause the California emission standards, in the aggregate, to be less protective of public health and welfare than applicable federal standards, will not cause the California requirements to be inconsistent with Section 202(a) of the Clean Air Act, and raise no new issues affecting previous waiver determinations of the Administrator of the Environmental Protection Agency pursuant to Section 209(b) of the Clean Air Act.

BE IT FURTHER RESOLVED that the Executive Officer shall forward the amended regulations to the Environmental Protection Agency with a request for confirmation that the amendments are within the scope of an existing waiver, pursuant to Section 209(b)(1) of the Clean Air Act.

BE IT FURTHER RESOLVED that the staff is directed to take appropriate action to credit the emission reductions provided by this action to California's commitment to reasonable extra efforts to attain the national ambient air quality standards for ozone and carbon monoxide. Credits for nitrogen oxides are to be applied in the South Coast Air Basin, Ventura County, and other parts of the state for which it is shown that reductions in the emissions of nitrogen oxides will reduce ambient ozone concentrations.

BE IT FURTHER RESOLVED that the staff is directed to take appropriate action to credit the emission reductions provided by this action to California's commitment to reasonable extra efforts to attain the national ambient air quality standards for ozone and carbon monoxide. Credits for nitrogen oxides are to be applied in the South Coast Air Basin, Ventura County, and other parts of the state for which it is shown that reductions in the emissions of nitrogen oxides will reduce ambient ozone concentrations.

Attachment 4

DRAFT

REGULATORY ANALYSIS, ENVIRONMENTAL IMPACT STATEMENT and NOx POLLUTANT SPECIFIC STUDY

for

PROPOSED GASEOUS EMISSION REGULATIONS FOR 1985 AND LATER MODEL YEAR LIGHT-DUTY TRUCKS AND 1986 and LATER MODEL YEAR HEAVY-DUTY ENGINES

PREPARED BY

OFFICE OF MOBILE SOURCE AIR POLLUTION CONTROL

APPROVED BY

Michael P. Walsh, Deputy Assistant Administrator
for Mobile Source Air Pollution Control

DATE: JAN 1981

D. Light-Duty Trucks - Gasoline

Table III-J presents data from actual certification tests conducted at EPA's Motor Vehicle Emissions Laboratory on 1980 Federal and California light-duty trucks. The sales-weighted average NOx emission level of 1980 light-duty trucks is approximately 1.50 g/mi for all fifty states; a 63 percent reduction is required to meet a low mileage emission target of .55 g/mi.

The lowest 1980 4K NOx emission level observed in an actual test at the EPA laboratory was .70 g/mi on a Volkswagen Bus (engine family 11, 120 CID, California calibration) with three-way catalyst, closed-loop feedback carburetor, and no EGR.

The light-duty vehicle NOx standard for 1981 is 1.0 g/mi (40 percent AQL, 50,000-mile useful life). The light-duty vehicle standard is very close to the proposed light truck standard. One production truck has achieved a low mileage emission level halfway between the proposed standard and the presumed target level using a three-way catalyst system but no EGR, i.e., additional control is possible. Admittedly this is only one vehicle, but light-duty trucks currently certify to a 2.3 g/mi standard and there has been no need in the past to design to lower NOx levels. Technology is already on the market today to allow light-duty vehicles to achieve a 1981 1.0 g/mi standard. Light-duty trucks should be able to comply with a .9 g/mi standard by 1985, despite the proposed changes to the AQL and useful life definition, if such a standard is deemed appropriate relative to that for light-duty vehicles.

The prime system candidate will likely be a three-way catalyst system with feedback carburetor with electronically controlled spark timing. EGR and dual bed catalysts may be necessary on larger GVW vehicles, but not on the majority.

E. Light-Duty Trucks - Diesel

Both General Motors and Volkswagen applied for and received a waiver from the 1981 LDV 1.0 g/mile NOx standard for diesel-powered vehicles. In their waiver submission it was claimed that excessive fuel economy and durability penalities were realized using EGR as the prime emission control system at a 1.0 gram/mile level. A two year extension with a two year review was granted by the Agency to allow development of new technology. In short, technology-forcing development work on advanced methods of NOx control is already underway and the results of that work will no doubt be applicable to light-duty diesel trucks in 1985. Certification to a .9 g/mile NOx standard will be possible, although tradeoffs associated with this level are uncertain. The staff sees no reason why, within the time frame of these proposed standards, technology will not be developed to minimize adverse consequences of a tight NOx standard for LDT diesels.

Attachment 5

Regulatory Impact Analysis, Oxides of Nitrogen Pollutant Specific Study and Summary and Analysis of Comments

Control of Air Pollution from New Motor Vehicles and New Motor Vehicle Engines: Gaseous Emission Regulations for 1987 and Later Model Year Light-Duty Vehicles, and for 1988 and Later Model Year Light-Duty Trucks and Heavy-Duty Engines; Particulate Emission Regulations for 1988 and Later Model Year Heavy-Duty Diesel Engines

March 1985

Environmental Protection Agency
Office of Air and Radiation
Office of Mobile Sources

the net present value aggregate cost in the year the standards begin. Costs to the nation were also expressed in terms of per vehicle investment in 1987. All values used throughout the chapter were 1984 dollars.

II. Summary and Analysis of Comments

A. LDT NOx Standard

1. 1988 NOx Standards

a. Cost to LDT Manufacturers

Comments on the manufacturer costs attributable to the new LDT NOx standards were neither numerous nor lengthy, with only two manufacturers estimating retail price increases due to hardware and RD&T. The price increases in the comments were stated without derivations, and the methods used by EPA to estimate the costs given in the NPRM were not challenged. The manufacturer and EPA final costs, however, were not based on comparable fleets. Manufacturer costs were based on only those vehicles requiring new technology, while the EPA final costs developed in the NPRM were expressed as an average over every LDGT or LDDT, including those vehicles which will already have the hardware in place prior to implementation of the standard. EPA developed an average per vehicle cost for a LDGT requiring new technology in the Draft RIA, as part of the process of developing the fleet average LDT costs. This cost ($140) was presented in the Draft RIA. The EPA and manufacturer cost estimates are as follows:

Retail Price Increase Per LDT

Draft Analysis	**$35**	**LDDT Average**
	$44-87	**LDGT Average**
	$140	**LDGT with new technology**
Chrysler	**$80**	**LDT with new technology**
Toyota	**$100-250**	**LDT, with new technology**

As can be seen, when the same figures -- cost per vehicle with new technology -- are compared, those given by the manufacturers are comparable to those estimated by EPA in the NPRM. Therefore, EPA sees no need to alter its analysis of the LDT component cost values or RD&T costs which were used to develop the average per vehicle values presented in the NPRM.

i. Fixed Cost

In developing the costs for the final rule, the original allocation for RD&T costs estimated by EPA for this standard will be used here, but shifted one year to concur with the

shift in the year of introduction of the standard. This amount is the sum of the RD&T costs for LDGTs and LDDTs, and totals $26,970,000.

ii. Variable Cost

The average costs have been updated to reflect manufacturer comments on projected technology mixes received in response to the NPRM. Present technology mixes are taken from 1985 model year certification data, which provides manufacturer sales projections by engine family and, hence, by emission control technology type. The manufacturer data from comments and the 1985 certification data provide the basis for revision of the projected technology mixes and subsequent revision of the average LDGT hardware costs, which are calculated in the same manner as used in the Draft RIA. The projected mixes were in most cases confidential on a manufacturer-specific basis, and are included here only in general form.

The new present (1985) and projected technology application mixes according to LDGT engine size are given in Table 3-1. The same information for all LDGTs combined is presented in Table 3-2. The 1985 model year mixes were converted to projected 1987 model year (pre-standard) mixes by applying technology changes on specific engine families as indicated by manufacturers in confidential comments to the NPRM. As noted in the NPRM, the comments verify that even with no increases in the stringency of the NOx standard, there is a clear trend away from oxidation catalyst systems to three-way-catalyst systems on LDTs, apparently for reasons such as improved driveability and fuel economy. The trend for LDGTs is predominantly toward three-way closed-loop systems as opposed to three-way open-loop systems. Therefore, this analysis projected that for the 1988 model year (the first year of the new standard), all remaining oxidation catalyst systems and all three-way open-loop systems will convert to three-way closed-loop technology.

The overall hardware cost for each vehicle undergoing a technology change, according to number of cylinders in the vehicle, is given in Table 3-3, which is a summary of Tables 3-4 through 3-6 in the Draft RIA. Costs are derived by subtracting the costs of hardware components removed from the costs of hardware components added; estimates of these costs were originally determined using the Rath and Strong methodology,[1] and are unchanged from the Draft RIA.

The hardware costs as presented in the Draft RIA and the projected change in the technology mix, as discussed above, are combined to give an average hardware cost upon implementation of the 1988 model year standard for $LDGT_1$s and for $LDGT_2$s as follows:

Table 3-1

Light-Duty Gasoline Trucks
Percent Technology Usage By Model Year and Engine Size

	Oxidation	Three-Way Open-Loop	Three-way Closed-loop	Three-Way Open-Loop plus Oxidation	Three-Way Closed-Loop plus Oxidation
$LDGT_1$:					
1985 MY*					
4-cylinder	23.8	0	35.9	0	1.8
6-cylinder	26.8	0	0	0	11.7
ALL	50.6	0	35.9	0	13.5
1987 MY projected**					
4-cylinder	21.2	0	38.5	0	1.8
6-cylinder	26.8	0	0	0	11.77
ALL	48.0	0	38.5	0	13.5
1988 MY projected**					
4-cylinder	0	0	59.7	0	1.8
6-cylinder	0	0	26.8	0	11.7
ALL	0	0	86.5	0	13.5
$LDGT_2$:					
1985 MY*					
6-cylinder	3.3	0	0	0	18.9
8-cylinder	34.0	0.8	18.4	8.7	15.9
ALL	37.3	0.8	18.4	8.7	34.8
1987 MY projected**					
6-cylinder	3.3	0	0	0	18.9
8-cylinder	15.6	0.8	36.8	8.7	15.9
ALL	18.9	0.8	36.8	8.7	34.8
1988 MY projected**					
6-cylinder	0	0	3.3	0	18.9
8-cylinder	0	0	53.2	0	24.6
ALL	0	0	56.5	0	43.5

---

* Based on manufacturers' confidential sales projections:
** Based on manufacturers' confidential comments to the NPRM.

Table 3-2

Light-Duty Gasoline Trucks
Percent Technology Usage by Model Years for All LDGTs

		Percent Technology Used		
Model Year	No Catalyst	Oxidation Catalyst	Three-way Open-Loop	Three-way*** Closed-Loop
1982*	4.2	91.2	0.2	4.4
1983*	1.4	80.3	0.0	18.3
1984*	0.0	58.0	11.0	31.0
1985*	0.0	43.3	4.9	51.8
1987**	0.0	36.9	3.6	59.5
1988 and later**	0.0	0.0	0.0	100.0

---

* **Based on confidential sales projections provided by manufacturers as part of the certification process.**

** **Projected based on confidential manufacturer comments to the NPRM.**

*** **Also includes three-way closed-loop plus oxidation catalyst systems (see Table 3-1).**

Table 3-3

Light Duty Gasoline Truck
Emission Control System Hardware
Cost Per Vehicle With New Technology

Technology Change		Engine Size		
From	To	4CYL	6CYL	8CYL
Oxidation	Three-way Closed Loop	$106	$133	$157
Three-way	Three-way Closed Loop	--	--	$65

- It is projected that 48 percent of all LDGT$_1$s will require technology changes between 1987 and 1988.

- First, 4-cylinder LDGT$_1$s, representing 21.2 percent of all LDGT$_1$ sales, are converted from oxidation catalysts to three-way closed-loop catalysts. At $106 per conversion, the contribution of 4-cylinder engines to the LDGT$_1$ hardware cost is: 0.212 X $106 = $22.47

- Six cylinder LDGT$_1$s, representing 26.8 percent of all LDGT$_1$s, are changed from oxidation catalysts to three-way closed-loop catalysts, at $133 per vehicle. The 6-cylinder contribution to the LDGT$_1$ hardware cost is then: 0.268 X $133 = $35.64

- The remainder of the LDGT$_1$ market, 52 percent, is projected to already have the required technology (38.5 percent three-way closed-loop catalysts and 13.5 percent three-way closed-loop plus oxidation catalysts) in place for the 1987 model year. (In fact, most of these vehicles, 49.4 percent of the market, already have the hardware on the 1985 model year vehicles.) No costs are incurred for these vehicles.

- The average hardware cost per LDGT$_1$ in the fleet is the sum of the contributions by the 4- and 6-cylinder engines and is: $22.47 + $35.64 = $58.11 or approximately $58.

- This cost is $121 per vehicle when applied only to those LDGT$_1$s requiring new technology in model year 1988.

The same methodology can be used for LDGT$_2$s:

- For the 3.3 percent of LDGT$_2$s which are 6-cylinder engines and which are converted from oxidation catalyst to three-way closed-loop catalyst technology, the cost is $133 per vehicle, which results in a contribution of: 0.033 X $133 = $4.43

- For the 15.6 percent of the LDGT$_2$ market which are 8-cylinder engines with oxidation catalysts and which will be changed to three-way closed-loop catalyst systems at a cost of $157, the resulting 8-cylinder contribution is: 0.156 X $157 = $24.49

derived from application of the new technology. That is, the average per vehicle hardware cost for the 1.2/1.7 standards is $29 per LDGT$_1$, and $18 per LDGT$_2$.

These LDGT costs can be combined with LDDT costs to give an overall LDT sales weighted hardware cost per vehicle. No comments specifically addressed the issue of LDDT hardware costs. Therefore, the costs developed in the Draft RIA will be used here. These LDDT costs are $20 per vehicle requiring the first time application of EGR, or LDDT$_1$s, and $42 per vehicle needing a conversion to electronically-controlled EGR from current EGR, or LDDT$_2$s; details of their derivation can be seen in the Draft RIA.

The average hardware cost per LDT can now be calculated using the LDGT costs developed above and the LDDT costs presented above. Sales weighting these costs will give the average per vehicle cost of the proposed LDT NOx standard.

- The 8-cylinder engines also have some open-loop three-way systems, which will go to closed-loop in model year 1988. Of the LDGT$_2$ market, 9.5 percent will need new closed-loop control (8.7 percent from three-way plus oxidation catalysts to three-way closed-loop plus oxidation catalysts, and 0.8 percent from three-way to three-way closed-loop catalysts) at $65 per vehicle, which makes this portion of the 8-cylinder contribution: 0.095 X $65 = $6.18
- The remainder of the LDGT$_2$ market, 71.6 percent, already will have three-way closed-loop catalyst or three-way closed-loop plus oxidation catalyst systems in place by model year 1987, and thus will incur no costs.
- The average hardware cost per LDGT$_2$ in the fleet is the sum of the 6- and 8-cylinder contributions and is: $4.43 + $24.49 + $6.18 = $35.10, or about $35.
- This cost, when distributed only over those vehicles requiring new technology, is about $123 per LDGT$_2$.

The average per vehicle hardware costs of $58 for LDGT$_1$s and $35 for LDGT$_2$s derived above include the total costs for hardware components added (three-way catalysts, feedback carburetor modifications, and/or closed-loop control), with a credit for those components removed (oxidation catalysts and/or open-loop control), averaged over the entire fleet of vehicles in that LDGT category. However, the complete cost of such hardware should not be applied solely to the more stringent NOx standard, since the manufacturer also derives other significant benefit from its application. This is indicated by the fact that manufacturers have already converted much of their fleet from oxidation to three-way catalyst systems, and have stated in their comments that they plan to continue this although it is not necessary from an emissions

Table 3-4

Projected Light-Duty Truck Sales (in thousands)*

Years	Gasoline**	Diesel**	Total
1988	3,070	420	3,490
1989	3,100	460	3,560
1990	3,010	530	3,540
1991	2,980	690	3,670
1992	2,890	850	3,740
Totals	15,050	2,950	18,000

---

* Total sales projections for 1988-1991 were drawn from the Draft RIA. 1992 projections were determined using the same methodology.

** Gasoline and diesel splits were taken from Chapter 4.

Table 3-5

Projected Market Share by LDT Subcategory, 1988-1992 Model Years

LDT Subcategory	Sales (thousands)	Market Share	Hardware Cost/Vehicle
$LDGT_1$	9,330	52%	$29
$LDGT_2$	5,720	32%	$18
$LDDT_1$	970	5%	$20
$LDDT_2$	1,980	11%	$42
Total	18,000	100%	$26*

---

* Sales-weighted average.

iii. Total Cost to Manufacturers

Total manufacturer cost of compliance with the LDT NOx standard is based on hardware costs for sales projected for the 5-year period beginning with the first model year of the standard plus the total costs for RD&T. These costs are then discounted at 10 percent to the first year of the standard (1988) so that costs over the years of interest can be expressed in equivalent dollars. It is projected that RD&T costs will be incurred as in Table 3-6, shown in both undiscounted and discounted form. Hardware cost is spent according to sales, and is shown in Table 3-7. Total manufacturer costs are combined in Table 3-8; as can be seen, the net present value of the manufacturer cost in 1988 is $426,820,000.

b. Cost to Users

i. First Cost

The added cost to manufacturers for RD&T and emission control system hardware is expected to be passed on to the purchasers of LDTs. The amount a manufacturer must increase the price of its vehicles to recover its expenses depends on the timing of the costs, the revenues from sales, and the cost of capital to the manufacturer. It is expected that manufacturers will increase the vehicle prices to recover their pre-production investment in five model years, 1988-92. When RD&T costs are amortized over the vehicle sales, the cost is $2 per LDT. The first price increase of a vehicle would be the sum of this cost plus the cost of the hardware, $26. The average first price increase for an LDT sold between 1988 and 1992 is thus $28; this is a sales-weighted average of the LDGT$_1$ cost of $31, LDGT$_2$ cost of $20, LDDT$_1$ cost of $22, and the LDDT$_2$ cost of $44, including the $2 per vehicle for discounted RD&T.

These costs can also be expressed in terms of only those vehicles requiring new technology rather than as an average per vehicle cost by adding RD&T apportioned over the applicable vehicles ($3 per LDGT and $2 per LDDT with new technology) to the hardware required for that vehicle as shown in Table 3-3. These costs are summarized in Table 3-9.

ii. Fuel Economy

Fuel economy impact was determined to be small, as discussed in Chapter 2, Technological Feasibility. For those vehicles with existing three-way systems which already meet the standards, no fuel economy penalty should be experienced, while those converting from oxidation to three-way catalyst systems

Table 3-6

LDT RD&T Costs for 1.2/1.7 NOx

	Undiscounted			Discounted		
	Non-Cert Costs	Cert Costs	Total	Non-Cert Costs	Cert	Total
1986	$9,000K	$1,900K	$10,900K	$10,890K	$2,299K	$13,189K
1987	$2,870K	$13,200K	$16,070K	$3,157K	$14,520K	$17,677K
	$11,870K	$15,100K	$26,970K	$14,047K	$16,819K	$30,866K

Table 3-7

LDT Hardware Costs for 1.2/1.7 NOx

	Undiscounted	Discounted*
1988	$92,350K	$92,350K
1989	94,200K	85,640K
1990	93,670K	77,410K
1991	97,110K	72,960K
1992	98,960K	67,590K
TOTAL	$476,290K	$395,950K

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* Discounted at 10 percent to 1988.

Table 3-8

Total LDT Manufacturer Cost

	Undiscounted		Discounted*	
	RD&T	Hardware	RD&T	Hardware
1986	$10,900K	--	$13,190K	--
1987	$16,070K	--	$17,680K	--
1988	--	$92,350K	--	$92,350K
1989	--	$94,200K	--	$85,640K
1990	--	$93,670K	--	$77,410K
1991	--	$97,110K	--	$72,960K
1992	--	$98,960K	--	$67,590K
	$26,970K	$476,290K	$30,870K	$395,950K
TOTAL	$503,260K		$426,820K	

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* Discounted at 10 percent to 1988.

Table 3-9

Light-Duty Trucks First Price Increases

Vehicles Requiring New Technology		
LDGT:		
4-Cylinder	Three-way Closed Loop from Oxidation Catalyst (LDGT$_1$)	$109
6-Cylinder	Three-Way Closed-Loop From Oxidation Catalyst (LDGT$_{1\,\&\,2}$)	$136
8-Cylinder	Three-Way Closed-Loop From Oxidation Catalyst (LDGT$_2$)	$160
8-Cylinder	Three-Way Closed-Loop From Three Way Open Loop (LDGT$_2$)	$ 68
LDDT:		
LDDT$_1$	First Time Application of EGR	$ 22
LDDT$_2$	Electronically Controlled EGR from EGR	$ 44
Average for All Vehicles		
LDGT$_1$		$ 31
LDGT$_2$		$ 20
LDDT$_1$		$ 22
LDDT$_2$		$ 44
All LDTs		$ 28

Attachment 6

Table 2-8

1985 Model Year Light-Duty Truck Fuel Economy
Federal vs. California Paired Data*

Mfr.	Engine**	Technology Fed.	Technology Calif.	Fuel Economy Combined MPG Fed.	Fuel Economy Combined MPG Calif.	Fuel Economy % Change	NOx Emissions Fed.	NOx Emissions Calif.	Calif. Std.
Gasoline, Same Technology									
AMC	2.5L(10)	3CL	3CL	23.4	22.5	-3.8	1.04	0.55	1.0
AMC	4.2L(7)	3CL	3CL	20.6	20.6	0	1.30	0.70	1.0
AMC	5.9L(1)	3WY	3WY	13.8	13.8	0	1.41	0.55	1.0
Chrysler***	5.2L(2)	3CL+OX	3CL+OX	14.8	14.8	0	0.74	0.74	1.0
Ford	2.3L(4)	3CL	3CL	29.8	29.4	-1.3	0.49	0.26	0.4
Ford	2.8L(7)	3CL+OX	3CL+OX	22.6	21.4	-5.3	1.51	0.66	1.0
Ford	4.9L(6)	3CL+OX	3CL+OX	17.2	16.7	-2.9	1.26	0.68	1.0
Ford	5.0L(2)	3CL+OX	3CL+OX	17.1	16.4	-4.1	0.83	0.54	1.0
GM ***	2.5L(19)	3CL	3CL	27.0	27.0	0	0.30	0.30	0.4
GM	4.3L(2)	3CL+OX	3CL+OX	22.6	22.0	-2.6	0.53	0.54	1.0
Nissan	2.4L(3)	3CL	3CL	23.3	23.1	-0.1	1.46	0.52	1.0
Mitsubishi	2.6L(13)	3CL	3CL	23.2	22.4	-3.4	1.27	0.64	1.0
Toyota ***	2.0L(4)	3CL	3CL	27.0	27.0	0	0.11	0.11	0.4
Toyota ***	2.4L(6)	3CL	3CL	25.4	25.4	0	0.14	0.14	0.4
VW	1.9L(2)	3CL	3CL	20.1	18.9	-6.0	0.92	0.39	0.4
Gasoline, Different Technology									
AMC	2.8L(1)	OX	3CL	20.5	22.1	7.8	1.80	0.76	1.0
Chrysler	5.2L(1)	OX	3CL+OX	15.5	15.2	-1.9	1.81	0.85	1.0
GM	2.8L(7)	OX	3CL	22.8	24.7	8.3	1.44	0.65	1.0
GM	4.3L(2)	OX	3CL	20.1	19.5	-3.0	1.57	0.47	1.0
GM	5.7L(1)	OX	3CL	13.9	14.2	2.2	1.80	0.80	1.0
Isuzu	1.9L(7)	OX	3CL	27.5	26.8	-2.6	1.77	0.41	1.0
Toyota	2.4L(4)	OX	3CL	28.8	27.2	-5.6	1.62	0.40	0.4
Fuji	1.8L(6)	OX	3CL+OX	27.3	28.6	4.8	1.78	0.20	0.4
Diesel									
GM	6.2L(7)	EGR	Elec EGR	23.5	23.3	-0.1	1.59	1.28	1.5

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* Data pairing requirements: equal engine displacement, transmission, N/V and inertia weight.

** Number in ( ) following engine size identifies the number of engine pairs used in calculating the mean fuel economy values shown.

*** No changes occur because this is a 50 state vehicle. Use of the same engine for Federal and California versions implies minimal fuel economy impact associated with the required low NOx level.

B. Summary and Analysis of Comments

1. Introduction

The comments received concerning the feasibility of the proposed LDT NOx standards are summarized and analyzed below. When more than one commenter raised the same basic issue, the issue is treated once in the summary and analysis with identification of the multiple sources of the comment. While the proposed standards are applicable to two types of engines (gasoline and diesel) used to power LDTs and are numerically different as a function of the weight of the LDT, comments will be treated by issue with appropriate consideration of these distinctions where necessary. The issues contained in the summary and analysis of comments which follows are, the technical feasibility of the proposed standards, the leadtime required for compliance, the effect of the standards on fuel economy and other minor issues.

2. Technical Feasibility of the Proposed Standards

Six commenters provided comments on the technical feasibility of the proposed standards with respect to gasoline-fueled LDTs. Chrysler, Ford, General Motors, Nissan and Toyota stated that the proposed standards (1.2 g/mi for LDGT$_1$s and 1.7 g/mi for LDGT$_2$s) were technologically feasible.

VW disagreed with the technical feasibility of the proposed standard on the grounds that the allowable maintenance provisions and the full-life useful life requirement result in requirements which are beyond the capabilities of current in-use or reasonably forseeable technology. VW did not, however, provide any information in substantiation of their statement. Lacking substantiating information for the VW statement and considering the position taken by the other commenters leads to the conclusion that the proposed standards are technologically feasible for LDGTs using the technologies identified in the Draft RIA (three way catalyst and closed loop fuel control). This is confirmed by certification data for the 1985 model year. As shown in Tables 2-1 to 2-7, nearly all LDTs certified with three-way closed loop technology are already in compliance with 1.2/1.7 standards. Both full-life useful life and revised allowable maintenance provisions apply to federally certified LDTs for 1985.

In the case of diesel fueled LDTs, three commenters provided comments on the technological feasibility of the proposed standards (1.2 g/mi and 1.7 g/mi). One commenter, Ford, stated that the proposed NOx standards were technologically feasible for LDDTs. Nissan stated that the standard proposed for LDDT's (1.2 g/mi) was feasible for some of its two-wheel drive vehicles, while its other LDDT's would need new EGR systems to control NOx while simultaneously complying with the particulate standard of 0.26 g/mi. GM stated that the ability of the 6.2 liter engine to comply with a NOx standard of 1.7 g/mi through the use of electronically controlled EGR would be marginal and would result in increased particulate emissions and a fuel economy penalty. GM provided a figure (Figure III-C-1 in the GM comments) depicting the NOx vs. particulate engine-out emission characteristics for the 6.2 liter engine in support of its position that particulate emissions would greatly increase under a 1.7 g/mi standard and jeopardize its ability to meet the LDT particulate standard of 0.26 g/mi.

Since all commenters concurred either fully or with some qualification with the technological achieveability of the proposed standards for LDDTs, analysis of the comments need focus only on the qualifying statements presented by the commenters.

In the Draft RIA (page 2-22), EPA concluded that all Federal LDDT's could be brought into compliance with the proposed NOx standard (1.2 g/mi) through the use of EGR system designs already being used on counterpart LDDT's certified to the California NOx standard. The thrust of the Nissan comment is that a new EGR system would have to be designed for use on some of its LDDT's rather than the transfer of an existing EGR system. Nissan is, therefore, concurring with the technological feasibility of the proposed standard by the use of EGR but is identifying a need for leadtime to design a new EGR system (leadtime requirements are addressed later).

In responding to the comment from GM, EPA has plotted 1985 model year certification data for the Federal and California versions of the 6.2 liter GM engine on the curve provided by GM in its Figure III-C-1 (reproduced here as Figure 2-1). These values are shown as F_1, and F_2 (1.90 g/mi NOx, 0.41 g/mi particulate and 1.90 g/mi NOx, 0.34 g/mi particulate) for the two federal vehicles using EGR and as C_1 and C_2 (1.7 g/mi NOx, 0.32 g/mi particulate and 1.3 g/mi NOx, 0.32 g/mi particulate) for the two California engines using electronically controlled EGR. As can be seen from Figure 2-1, NOx and particulate emissions actually being achieved are substantially lower than the generalized curve presented by GM. In addition, because the 6.2 liter GM engine is already very close to the particulate standard on an engine-out basis, EPA can see no basis for GM's concern about meeting the particulate standard. The application of particulate traps to

Attachment 8

DRAFT

REGULATORY ANALYSIS, ENVIRONMENTAL IMPACT STATEMENT and NOx POLLUTANT SPECIFIC STUDY

for

PROPOSED GASEOUS EMISSION REGULATIONS FOR 1985 AND LATER MODEL YEAR LIGHT-DUTY TRUCKS AND 1986 and LATER MODEL YEAR HEAVY-DUTY ENGINES

PREPARED BY

OFFICE OF MOBILE SOURCE AIR POLLUTION CONTROL

APPROVED BY

Michael P. Walsh, Deputy Assistant Administrator
for Mobile Source Air Pollution Control

DATE: JAN 1981

CHAPTER III

TECHNOLOGICAL FEASIBILITY

As determined by the baseline test program, the mandated 75 percent reduction in NOx emissions from the uncontrolled level resulted in a standard of 1.7 grams per brake horsepower-hour for heavy-duty engines, and .90 grams/mile for light-duty trucks. The ability to comply with these standards depends firstly upon whether an engine is gasoline or diesel-fueled. Secondly, the 10 percent AQL and full life deterioration factors require low mileage emission targets well below the level of the standards.

A. Low-Mileage Emission Targets

For the purposes of this analysis, the staff will use the low-mileage emission target levels presented in Table III-A. Hydrocarbon (HC) and carbon monoxide (CO) emission targets are identical to those used in the 1984 Heavy-Duty Engine and Light-Duty Truck HC and CO Rulemakings. Since NOx emissions at these levels are related to HC and CO, it is appropriate that these targets also be discussed.

B. Heavy-Duty Gasoline Engines

The NOx emission levels of several current technology heavy-duty gasoline engines are presented in Table III-B. Note that the average level of NOx emissions is not substantially lower than the 1972-73 baseline level.

It is the staff's judgement that achievement of the full 75 percent reduction, i.e., a reduction to the level of the 1.01 g/BHP-hr emission target level, is technologically feasible through the application of three-way catalyst technology, and certainly if used in conjunction with oxidation catalysts to maintain the 90 percent HC and CO reductions. Additional NOx control, if necessary, could also be provided by EGR. This judgement is based upon a test program conducted at the EPA Motor Vehicle Emission Laboratory in which a three-way/oxidation catalyst system was retrofit on a 1978 IHC 404 CID V-8 heavy-duty gasoline engine (California calibration).

A summary of the results of this test program are contained in Table III-D. Technical specifications of equipment used in the program are presented in Table III-E. A comprehensive discussion of this test program will be published in a forthcoming SAE paper, tentatively entitled, "The Application of a Three-Way Conversion Catalyst System to a Heavy-Duty Engine," to be presented at the SAE Congress in March 1981.

Examination of the data reveals several things. Total three-way catalyst volume of 300 cubic inch in configuration 3 (for a

Attachment 9

REGULATORY ANALYSIS AND ENVIRONMENTAL IMPACT OF FINAL EMISSION REGULATIONS FOR 1984 AND LATER MODEL YEAR LIGHT-DUTY TRUCKS

PREPARED BY

OFFICE OF MOBILE SOURCE AIR POLLUTION CONTROL

APPROVED BY

Michael P. Walsh

Michael P. Walsh, Deputy Assistant Administrator for
Mobile Source Air Pollution Control

Date: 5/20/80

Table II-B
Emission Standards for Light-Duty Trucks
(g/mile)

Federal

Year	HC	CO	NOx	Evap.1/	Particulate 8/
1968-74 7/					
1975	2.0	20	3.1	2.0	--
1978	2.0	20	3.1	6.0 2/	--
1979 3/	1.7	18	2.3	6.0	--
1981	1.7	18	2.3	2.0 2/	--
1982 2/	1.7	18	2.3	2.0	.6
1983 6/	.8	10	2.3	2.0	.6
1985 6/	.8	10	75%		.26

California

		0-6,000 GVWR			6,001-8,500 GVWR			All
Year	IW	HC	CO	NOx	HC	CO	NOx	Evap.1/
1975	All	2.0	20	2.0	Same as HD			
1976	All	0.9	17	2.0				
1977	All	0.9	17	2.0				
1978	All	0.9	17	2.0	0.9	17	2.3	6.0 2/
1979	0-3999	0.41 4/	9.0	1.5	0.9	17	2.3	6.0
	4000-6000	0.50	9.0	2.3	0.9	17	2.3	6.0
	6001-8500	--	--	--	0.9	17	2.3	6.0
1980	0-3999	0.41 4/	9.0	1.0(1.5)5/	0.9	17	2.3	2.0 2/
	4000-6000	0.50	9.0	2.0(2.3)5/	0.9	17	2.3	2.0
	6001-8500	--	--	--	0.9	17	2.3	2.0
1981 & 1982	0-3999	0.41 4/	9.0	1.0(1.5)5/	0.41 4/	9.0	1.0(1.5)5/	2.0
	4000-6000	0.50	9.0	2.0(2.3)5/	0.50	9.0	1.5(2.0)5/	2.0
	6001-8500	--	--	--	0.60	9.0	2.0(2.3)5/	2.0
1983	0-3999	0.41 4/	9.0	0.4(1.0)5/	0.41 4/	9.0	0.4(1.0)5/	2.0
	4000-6000	0.50	9.0	1.0(1.5)5/	0.50	9.0	1.0(1.5)5/	2.0
	6001-8500	--	--	--	0.60	9.0	1.5(2.0)5/	2.0

1/ Gasoline vehicles only (g/test).

2/ SHED test.

3/ Federal LDT class was expanded for 1979 MY to include most vehicles up to 8,500 lbs. GVWR.

4/ Compliance with 0.39 g/mi non-methane is optional.

5/ Optional 100,000 mile durability NOx standard.

6/ Clean Air Act requires 90% HC and CO reduction in 1983 and 75% NOx reduction in 1985 for vehicles over 6,000 lbs. GVWR.

7/ Prior to 1975 LDTs up to 6,000 lbs. GVWR were classified as LDVs.

8/ Diesel vehicles only.

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860622

Reducing the Sulfur and Aromatic Content of Diesel Fuel: Costs, Benefits, and Effectiveness for Emissions Control

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Sobotka and Company, Inc.

International Congress and Exposition
Detroit, Michigan
February 24—28, 1986

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ABSTRACT

Diesel engines in light and heavy-duty vehicles emit significant amounts of oxides of nitrogen (NO_x), particulate matter, sulfur oxides, and unburned hydrocarbons. Emissions of these pollutants are strongly affected by the quality and composition of the diesel fuel used. This report reviews the published literature concerning fuel effects on diesel emissions, and examines the feasibility, costs, and cost-effectiveness of reducing diesel emissions by means of changes in diesel fuel composition. Two specific changes are considered: a drastic reduction in diesel fuel sulfur content; and the same sulfur reduction along with a moderate reduction in the aromatic hydrocarbon content. The effects of each change on engine durability, fuel economy, and refining costs are considered together with the emissions effects. The results indicate that the cost of producing low-sulfur diesel fuel would be more than offset by savings in reduced maintenance and greater engine life. Re-optimizing the refining process to produce low-sulfur fuel would also reduce the aromatic hydrocarbon content, improving ignition quality and reducing particulate emissions. A further reduction in aromatic content would be feasible, and would have superior cost-effectiveness to some other particulate control measures such as particulate traps.

The nature and quality of the fuel being burned affects the emissions from virtually every class of engine. In diesel engines, these effects can be either positive (resulting in reduced emissions) or negative, depending on the fuel and the engine. In the last decade, disruptions in the supply of oil, rapid increases in its cost, and the exhaustion of higher-quality stocks have led to the widespread use of heavier and higher-sulfur crude oils, with a consequent deterioration in ignition quality, sulfur content, and other indices of consumption relative to gasoline and the phase-out of lead antiknocks in gasoline have also contributed to this trend. Most knowledgeable observers anticipate that fuel quality will continue to deteriorate in the future if market forces are permitted to operate freely.

The prospect of further degradation in fuel quality has generated concern for the possible effects of these changes on emission levels. At the same time, concern over diesel emissions in general has led to the establishment of stringent new emissions standards for oxides of nitrogen (NO_x) and particulate material from new light-duty diesel vehicles and heavy-duty diesel engines. The steps taken to meet these requirements will place new demands on fuel quality. For example, the changes in fuel injection timing in heavy-duty engines required to comply with the NO_x standard will make them more sensitive to ignition quality than heretofore. The presence of contaminants such as sulfur and ash in diesel fuel has also complicated the development of trap-oxidizers for particulate control.

The establishment of emissions standards for new vehicles has focussed attention on the large number of existing diesel vehicles which will not be affected by the standards. Improving diesel fuel quality is one apparently reasonable approach to reducing emissions from these vehicles, and has attracted considerable attention for this reason. In a first step down this road, the California Air Resources Board (CARB) has recently established a limit of 0.05 percent sulfur by weight for diesel fuel sold in the South Coast Air Basin, and is considering extending this limit to the rest of California.

This paper summarizes the results of an EPA-funded study of the feasibility and cost-effectiveness of diesel emissions control through fuel modifications. The full report of the study is given in (1). This study included of a thorough review of the recent technical literature dealing with diesel fuel properties; fuel effects on emissions, durability, and performance; and related topics. This was supplement-

0148-7191/86/0224-0622$02.50
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ed by numerous telephone and in-person discussions with refiners, engine manufacturers, and other knowledgeable parties. The information developed in this review was used to develop two scenarios for improved diesel fuel quality. The first scenario consisted of a reduction in the sulfur content of diesel fuel to 0.05 percent by weight, while the second included the same sulfur reduction together with a decrease in aromatic content. A linear-program refining cost model was used to estimate the cost to the refining industry of meeting each scenario. These results were combined with data from the literature review in order to assess the effects of each fuel-quality change on emissions, engine durability, fuel economy, and costs.

REVIEW OF FUEL EFFECTS ON ENGINES AND EMISSIONS

Studies of the effects of changes in fuel properties on engine performance and emissions are complicated by the fact that few changes in fuel properties can be carried out independently -- there are strong correlations between individual properties, and it is seldom clear which is the property of greatest interest. The properties singled out for discussion here are those which are generally considered (either for theoretical reasons or from practical experience) to be the critical ones from an emissions and performance standpoint. These are: sulfur content, aromatic content and ignition quality, and back-end volatility.

EFFECTS OF SULFUR IN DIESEL FUEL -- The ASTM standard for automotive diesel fuel (2) specifies a maximum sulfur content of 0.5 percent by weight. Diesel fuel sold in the U.S. normally contains between 0.1 and 0.5 percent sulfur, with the average in 1984 being about 0.27 percent, according to the surveys conducted by the National Institute for Petroleum and Energy Research (3). This average has increased somewhat since 1980. Another survey of diesel fuel properties by the Motor Vehicle Manufacturer's Association shows an even sharper increase in sulfur content, from a median of 0.19 percent in 1980 to 0.31 percent in 1983 (4).

Environmental effects -- Sulfur in diesel fuel contributes to environmental deterioration both directly and indirectly. Most of the sulfur in the fuel burns to SO_2, which is emitted to the atmosphere in the diesel exhaust. Because of this, diesels are significant contributors to ambient SO_2 levels in some areas. In California's South Coast Air Basin, diesels are projected to account for 24 percent of all SO_2 emissions, despite a requirement that large refiners market desulfurized fuel (5). Nationwide, diesel fuel accounted for about 370,000 tons of SO_2 emitted in 1985. Most of the sulfur which is not emitted as SO_2 is converted to SO_3 during the combustion process. This gas combines with water in the exhaust to form sulfuric acid (H_2SO_4), and with metals in the fuel and oil to form various metal sulfates. Both of these materials are emitted in particulate form. The typical rate of sulfur conversion to sulfates in a heavy-duty diesel engine is about 1 to 3 percent of the fuel sulfur; and about 3 to 5 percent in a light-duty engine. Even at this rate, sulfate particles typically account for 0.02 to 0.05 g/BHP-hr of particulates in heavy-duty engines. The effect of the sulfate particles is increased by their hygroscopic nature, since they tend to absorb significant quantities of water from the air.

Certain precious-metal catalysts, such as those used in catalytic converters and catalytic trap-oxidizers, promote the oxidation SO_2 to SO_3. The rate of conversion with the catalyst is dependent its activity -- catalyst formulations which are most effective in oxidizing hydrocarbons and carbon monoxide are generally also most effective at oxidizing SO_2. The presence of significant quantities of sulfur in diesel fuel thus limits the catalytic activity possible in the trap, making regeneration more difficult (6-7). Low sulfur fuel would make catalysts and catalytic traps more effective for particulate (as well as hydrocarbon and odor) reduction.

Sulfur dioxide in the atmosphere oxidizes to form sulfate particles, in a reaction similar to that which occurs with the precious-metal catalyst. Viewed in another way, the presence of the catalyst merely speeds up a reaction which would occur anyway (although this can have a significant effect on human exposure to the reaction products). According to analysis by the California Air Resources Board staff (8), roughly 1.2 lb of secondary particulate is formed per pound of SO_2 emitted. For a diesel engine burning fuel of 0.3 weight percent sulfur at 0.42 lb of fuel per horsepower-hr, this is equivalent to 1.4 grams per horsepower-hr. For comparison, the average rate of primary or directly-emitted particulate emissions from heavy-duty diesel engines in use was about 0.8 grams/BHP-hr in a recent study (9). Sulfate particles are major contributors to ambient levels of total suspended particles (TSP) and particles of less than 10 microns diameter (PM10), and they also play a major role in acid deposition.

Quite aside from its particulate-forming tendencies, sulfur dioxide is recognized as a hazardous pollutant in its own right. The health and welfare effects of SO_2 emissions from diesel vehicles are probably much greater than those of an equivalent quantity emitted from a utility stack or industrial boiler, since diesel exhaust is emitted close to ground level in the vicinity of roads, buildings, and other concentrations of people.

Engine durability effects -- Sulfur in diesel fuel has been recognized for many years as a major -- and probably the major -- cause of wear in piston rings and cylinder liners (10-14). The rings and liners are generally the critical wearing parts in the diesel engine, so that the rate of wear in these parts is directly related to the frequency of engine overhauls. Sulfur contributes to ring and liner wear through two mechanisms: corrosive wear and deposit formation. Corrosive wear occurs when the sulfur in the combustion products and blowby gases attacks and corrodes the exposed metal surfaces. Corrosion is most severe when liner temperatures are below the dewpoint of sulfuric acid in the exhaust gases, since this allows sulfuric acid to condense on the surface. This occurs during cold starting and warmup, and can also occur at light loads. Turbocharging (which raises the acid dewpoint) exacerbates the problem (14).

Although corrosive wear is most severe under low-temperature conditions, it is not limited to these conditions -- experiments with fuels of different sulfur levels have shown that it also occurs (at a slower rate) even at normal operating temperatures. In addition to their direct attacks on rings and liners, the sulfur compounds in the blowby gases can combine with and acidify the oil. If unchecked, this leads to rapid corrosion and wear of bearings, camshafts, and other lubricated parts, and can lead to rusting if condensed water is present in the crankcase.

In order to keep the detrimental effects of sulfur within bounds, all heavy-duty engine oils are now formulated with highly alkaline dispersant additives. These additives are typically based on metals such as calcium and magnesium which combine with and neutralize the acid. Without such additives, or where the additives have been depleted by combining with the acids in the blowby, corrosive wear rates with high sulfur fuel are very high (12); with them, wear rates can be kept within reasonable bounds.

The greater the concentration of alkaline additives in the oil, the greater the degree of protection against corrosive wear. The permissible additive concentration is limited by other considerations, however, to a maximum of about 6-10 Total Base Numbers or TBN (13). One TBN is an alkali concentration equivalent to 1 mg of potassium hydroxide per gram of oil. The rate of neutralization of the alkaline additives is proportional to the rate of sulfur addition to the oil, which is proportional to the product of the sulfur content of the fuel and the blowby rate.

In addition to corrosive wear, ring scuffing and sticking and loss of oil control due to hard coky deposits on the piston are the other major sources of wear on piston rings and cylinder liners. Deposit formation at low and moderate temperatures is heavily affected by sulfur: low sulfur fuels result in fewer and lighter deposits (15). At high temperatures, such as those in the top land of the piston, sulfur does not directly affect deposit formation. There is an indirect effect, however, since the alkaline additives in the engine oil are also responsible for the control of piston and other engine deposits, and their dispersant activity is lost as they are neutralized by combination with sulfur.

Presently, additive depletion is a limiting factor in the length of time permissible between oil changes (other limiting factors are soot accumulation, contamination with water or fuel, and oxidation of the oil). Greatly reducing sulfur might make it possible to extend oil change intervals significantly. Alternatively, or perhaps in addition, the amount of metallic additive in the oil could possibly be reduced. This would be desirable for trap-oxidizer equipped vehicles, since the noncombustible metal sulfate ash from the alkaline additives is collected by and eventually clogs ceramic monolith traps (16-17).

Generally, the use of alkaline additives with adequate oil change frequency has resulted in acceptable wear rates and engine lifetimes with fuel of less than 0.5 percent sulfur by weight. However, despite the presence of alkaline additives, engine wear rates are greater with more sulfur in the fuel, and most observers agree that use of very low sulfur fuel would probably extend engine life. Applicable recent quantitative data comparing the effects of moderate vs. very low sulfur levels in automotive engines are scarce, however. There is abundant information concerning the effects of high-sulfur fuel in shortening engine life, but virtually no data on the effects of very low-sulfur fuel in lengthening it.

Figure 1, taken from a study by Tennyson and Parker (18), represents the best available information on the effects of very low sulfur fuels on relative wear rates. The figure shows the effects of fuel sulfur on piston ring wear rates in a two cycle locomotive engine as a function of the total base number (TBN) remaining in the oil. For a number of reasons, the corrosive wear rates measured in this study are probably lower than those which would be experienced in automotive engines. Tennyson and Parker took data at high loads and in steady-state operation, and care was taken that the

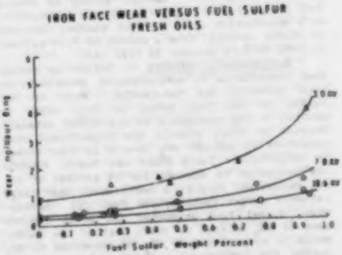


Figure 1. Effect of fuel sulfur content and oil alkalinity on piston ring wear rates in a locomotive engine (18).

engine was not allowed to cool down in order to prevent possible condensation. High-load operation promotes abrasive wear, while condensation greatly increases corrosive effects. Thus, the curves in Figure 1 probably show the minimum effect of low sulfur fuel -- that which would be observed in constant high-power operation. The difference in wear rates would be expected to be much higher during warm-up and light-load operation.

Even given these limitations, the data in Figure 1 have important implications for engine life and overhaul frequency when using low-sulfur fuel. The TBN of an oil declines in use, as the alkaline additives are depleted by combination with sulfur. For a typical heavy-duty oil with an initial TBN of 6 t0 10, the average TBN over the period between oil changes is probably somewhere between 4 and 7, depending on the sulfur content of the fuel and the blowby rate of the engine. For this TBN, Figure 1 indicates that going from 0.3 percent sulfur to 0.05 percent would decrease wear rates by about 30-40 percent, while going from 0.3 percent to the maximum of 0.5 percent permitted by the ASTM standard would increase wear by about 40 percent. Extended over the life of the engine, these differences should be reflected in a corresponding increase or decrease in engine life and mileage between overhauls.

It should be emphasized that these are probably minimum differences -- during warmup and low-load conditions the effect of sulfur levels is much greater. Figure 2, taken from a paper by Peugeot (19), shows relative rates of ring wear during warm-up as a function of fuel sulfur. This plot shows roughly a 65 percent reduction in wear in going from 0.3 percent to 0.05 percent sulfur. Automotive diesel engines experience varying duty cycles, but many see a significant amount of cold operation, and wear during starting and warmup is disproportionately high. Thus, the cumulative effect of the large differences in wear rates shown could be quite significant.

It should be noted that laboratory tests of wear rates, even relative wear rates, require corroboration by field experience before they can be considered reliable. To date, controlled tests of wear rates and engine life with low-sulfur diesel fuel do not appear to have been done. Thus the quantitative estimates given in the preceding paragraphs should be considered somewhat speculative, although the directional effect of reduced sulfur on engine durability is not in doubt. Experience gained in the South Coast Air Basin, where low-sulfur fuel is now mandatory, may provide better quantitative estimates of wear effects in a few more years. Further research in this area -- including carefully controlled field tests -- would be highly desirable.

EFFECTS OF AROMATIC CONTENT -- The volume fraction of aromatic hydrocarbons in the fuel has important effects on emissions, noise, and performance in diesel engines, and an indirect effect on fuel economy. The emissions and performance/fuel economy effects are discussed separately below.

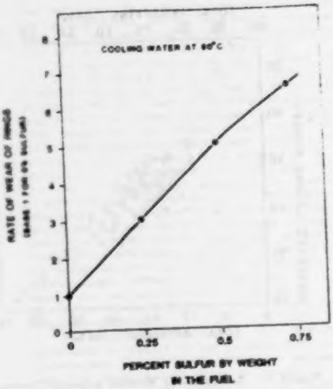


Figure 2. Effect of fuel sulfur content on piston ring wear rate during engine warmup in an automotive diesel engine (19).

Emissions effects -- The emissions effects of aromatics are due to at least two and possibly three causes. The first is the close correlation between aromatic content and ignition quality. Figure 3 shows the relationship between aromatics and ignition quality for a large number of fuel samples. The second effect is due to the greater density of aromatic hydrocarbons, so that highly aromatic fuels are denser than less aromatic ones. Since fuel injection systems meter by volume, a greater mass of highly aromatic fuel can be injected into the cylinder. This increases the power output of the engine slightly, but can also raise the fueling rate above the smoke limit. A third, possible effect on emissions may result from the greater soot-forming properties of aromatics. This tendency is well-demonstrated in steady-state combustors, but its relative importance for diesel engine emissions is not known.

The effects of aromatic content on emissions appear to be different for light-duty IDI and heavy-duty DI engines. Emissions levels in IDI engines appear to be fairly sensitive to ignition quality, as measured by the cetane

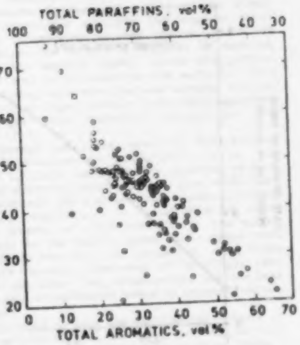


Figure 3. Relationship between aromatic content and cetane number (20).

number, while those in heavy-duty DI engines are not. This may be due to differences in the effect of cetane number on ignition delay. In a naturally aspirated IDI engine, Olree and Lenane (21) found a good correlation between measured ignition delay and cetane number for a variety of operating conditions, while a cooperative study by Caterpillar and Mobil (22) found no correlation between the two in a highly turbocharged, intercooled heavy-duty engine. It appears that, for heavy-duty engines, cetane is mostly important for cold starting, and does not greatly affect warmed-up emissions levels as long as the ignition quality is sufficient to allow normal combustion.

Measurements of aromatic content effects on emissions are also sensitive to the testing conditions used, and to the specific engine model being tested. For instance, in a series of light-duty tests conducted for the Coordinating Research Council (23), workers at Southwest Research found a significant correlation between aromatic content and particulate emissions for each of four light-duty automobiles. The magnitude of the regression coefficient relating the two, however, varied by a factor of more than eight from one engine to another. Major differences were also found between the effects measured on the Federal Test Procedure cycle and those measured at 30 and 56 MPH cruise conditions. Bergin (24) also found large differences in the effects of aromatics as a function of engine load.

The dependence of aromatic effects on the specific test cycle also appears in heavy-duty engines. The Caterpillar/Mobil study (22) found major differences in aromatic effects in a modern heavy-duty engine between the Federal Heavy-Duty Transient test cycle and the earlier 13-mode test. The engine used was a Caterpillar 3406B turbocharged/aftercooled line-haul truck engine, which had been calibrated for a low NO_x emission rate of 6.5 g/BHP-hr. This engine can be considered typical of those that will be used in heavy-heavy service in the late '80s. The fuels used for comparing aromatic effects were specially compounded so that they had similar back-end volatility and sulfur content, and the fuel pump was adjusted to compensate for variations in the fuel's volumetric energy content. Thus, the only major emissions-related parameter being varied was the aromatic content.

Figures 4 through 6 compare the test results obtained in the Caterpillar/Mobil study for particulates, NO_x, and hydrocarbons as a function of aromatic content. Data were obtained on both the EPA transient and the 13-mode cycle. As the figures indicate, HC and particulate data for both tests lie along reasonably straight lines. However, the slopes of the two regression lines for the transient test differ from those for the steady-state 13-mode cycle by an order of magnitude! It is speculated that the differences may be due to transient over-

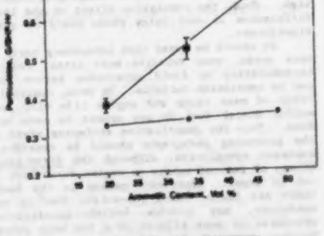
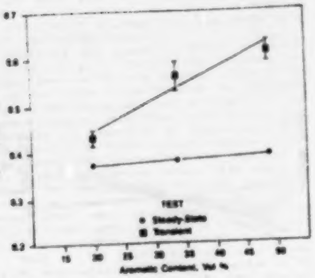
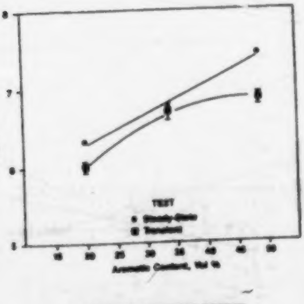


Figure 4. Effects of fuel aromatic content on particulate emissions: steady state vs. transient tests on a heavy-duty engine (22).



AROMATIC CONTENT EFFECT ON HYDROCARBONS

Figure 5. Effects of fuel aromatic content on hydrocarbons emissions: steady state vs. transient tests on a heavy-duty engine (22).



AROMATIC CONTENT EFFECT ON OXIDES OF NITROGEN

Figure 6. Effects of fuel aromatic content on NO_x emissions: steady state vs. transient tests on a heavy-duty engine (22).

fueling resulting from turbocharger lag during the accelerations in the heavy-duty transient test. In contrast, the NO_x results from the two sets of tests are reasonably comparable.

Two important conclusions can be drawn from the data in Figures 4 through 6. First, the aromatic content of the fuel has a significant effect on HC, NO_x, and particulate emissions as measured in the Federal transient test. Second, data taken on the 13-mode steady-state test cycle (and presumably other steady-state cycles, cannot be used to predict fuel effects on HC or particulates measured on the transient test. The same is also true of extrapolation from the 13-mode test to in-use emissions. The transient test cycle was designed to be representative of conditions in actual use (although there is considerable controversy over the extent to which this was actually achieved). The 13-mode and other steady-state cycles, in contrast, do not represent in-use operation well at all. Thus, any extrapolation of laboratory test results to in-use emissions is best done using transient-cycle data.

The restriction to using only transient cycle data to predict in-use emission effects is inconvenient, since such data are extremely rare. A comprehensive study — funded by the Coordinating Research Council — to examine fuel effects on a number of heavy-duty engines is now underway at Southwest Research Institute (25). The data from this study will not be available for at least two years, however. In the meantime, only two applicable heavy-duty engine studies are available in the literature. One of these is the cooperative Caterpillar/Mobil study cited above, the other was conducted for Chevron by Southwest Research Institute. Partial results for the latter study were reported by Wall and Hoekman (26), but the authors did not report numerical data for the transient test — only the fact that "statistically significant" relationships between aromatic content and particulates and between sulfur content and particulates (but not between back-end volatility and particulates) were found.

At a fuel sulfur level of 0.25 percent, the relationship between aromatic content and particulate emissions for the Caterpillar 3406B engine tested in the Caterpillar/Mobil study was roughly

$$\text{Particulate} = 0.143 + A \times 0.0113 \quad \text{(eq. 1)}$$

where particulate is in grams per BHP-hr and A is the aromatic content of the fuel in percent. However, about 0.033 g-BHP/hr of sulfate were included in the particulates in each test (this low level was due to storing the filters over a dessicant to remove the bound water). Subtracting this value from the constant term in Equation 1 gives

$$\text{Carbonaceous Part.} = 0.110 + A \times 0.0113 \quad \text{(eq. 2)}$$

where the units are the same as for Equation 1. "Carbonaceous particulate" is defined to include both the sooty fraction and the soluble organic portion of the particulate material, but not the inorganic sulfates. Since variations in aromatic content could only affect emissions of carbonaceous particulate, this is the appropriate variable to consider.

For unburned hydrocarbons, the Caterpillar/Mobil data give the following equation:

$$\text{Hydrocarbon} = 0.323 + A \times 0.086 \quad \text{(eq. 3)}$$

where hydrocarbons are in grams per BHP-hr and aromatics are in volume percent. Equations 2 and 3 are valid only for a single engine, and are based on only a single series of tests, which may not have been completely representative of in-use operation. They should thus be considered as only approximate indicators of fuel effects on in-use emissions.

A great many studies of fuel effects on light-duty diesel emissions have been reported in the literature. Bykowski and coworkers (27) have summarized and combined the data from a number of these studies. Most of these studies agreed in finding that aromatic content and back-end boiling point are the important variables affecting emissions. Unfortunately, none of the studies examined fuel sulfur as an independent variable, nor did Bykowski and coworkers reanalyze for sulfur effects. Since sulfur content is now known to have a strong effect on particulate emissions, this casts serious doubt on the validity of the correlations developed.

In addition to possible confounding of aromatic and sulfur effects, it appears that the effects of aromatic content on light-duty particulate emissions vary greatly from engine to engine. Figure 7, taken from Bykowski et alia shows the regression lines relating aromatics to particulate emissions calculated for each of a number of different studies. As the figure shows, these studies do not all agree even on the sign of the effect, much less on its magnitude.

From the data at hand, it is impossible to give a reliable quantitative estimate of the change in light-duty diesel emissions that would result from a change in aromatic content. As an order-of-magnitude estimate, the regression line for all petroleum-derived fuels calculated by Bykowski, et alia may be representative. This line is shown in Figure 8.

Effects on fuel economy, performance and durability -- As Figure 3 indicated, the aromatic content of diesel fuel is closely correlated with its ignition quality, as measured by the cetane number. Cetane numbers are important for cold starting of both DI and IDI engines, but especially for DI engines, since the universal use of glow plugs on IDI engines makes them less susceptible to starting problems. Daimler-Benz (28) has stated that 45 cetane is the minimum allowable for cold starting, while numbers above

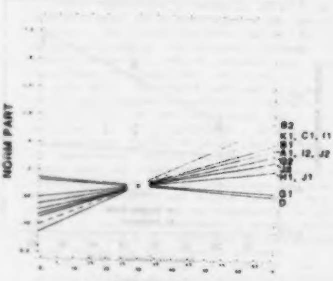


Figure 7. Regressions of particulate emissions vs. fuel aromatic content from a number of studies using different light-duty engines (27).

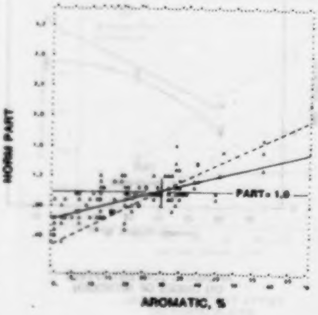


Figure 8. Regression of particulate emissions vs. fuel aromatic content: combined data from a number of light-duty engine studies (27).

50 are much preferred. By this criterion, almost all U.S. diesel fuels would be marginal at best, while a large fraction would give unsatisfactory performance.

Reducing the aromatic content of diesel fuel may slightly reduce fuel economy and maximum power in existing engines. This is due to the fact that a less aromatic fuel contains slightly less energy per unit of volume. In new engines, however, this effect would be more than offset by the reduction in compression ratio made possible by higher cetane numbers. Presently, heavy-duty DI engines are required to have higher compression ratios than would be optimal for fuel economy in order to ensure satisfactory cold starting (29). If a higher cetane level were guaranteed, manufacturers could decrease compression ratios slightly, with significant benefits in fuel economy.

Much of the noise produced by a diesel engine, especially at light loads, is due to the rapid pressure rise which results from premixed burning due to the ignition delay. A lower-aromatic fuel would reduce this noise by reducing the ignition delay, while a highly aromatic fuel would increase it. A fuel with sufficiently poor ignition quality could even affect the durability of the engine, due to the high transient pressures resulting from the long ignition delay period. This is not a significant problem at present, except for marginal fuels, but could conceivably become a problem if fuel quality continues to decline.

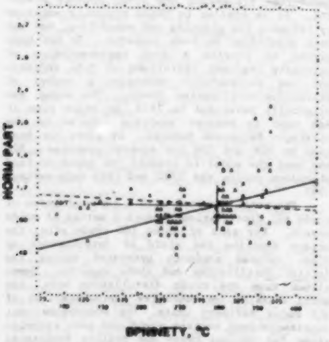


Figure 9. Regression of particulate emissions vs. fuel 90 percent point: combined data from a number of light-duty engine studies (27).

EFFECTS OF BACK-END VOLATILITY -- Many discussions of fuel effects on particulate emissions have concentrated on the 90 percent point, end point, or other indicators of back-end volatility. A number of studies have indicated significant correlations between back-end volatility and particulate emissions in light duty vehicles (30-31). Researchers at Chevron, however, have shown that these results may have been confounded with the effects of sulfur, which is strongly correlated with back-end volatility in petroleum-derived fuels (32).

Sykowski and coworkers (27) combined the results of 11 studies of fuel effects on emissions in light-duty vehicles. Figure 9 is a plot of normalized particulate emissions versus fuel 90-percent point for the combined data, along with the best-fit lines calculated for petroleum-derived fuels (solid line) and alternative fuels (dashed line). As the figure shows, these data are highly scattered, and neither regression equation predicts very well. In addition, the fact that the slope of the regression line for alternative fuels is nearly zero (and negative) while that for petroleum-derived fuels is larger and positive strongly suggests that the results are being confounded by some other variable, such as sulfur content.

Bergin (24) used a variety of low-sulfur fuels to examine the effects of aromatic content and 90 percent point on light-duty emissions as functions of engine load. He found that 90

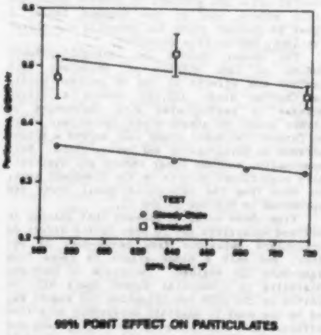


Figure 10. Effects of 90 percent point on particulate emissions: transient vs. 13-mode steady-state cycle (22).

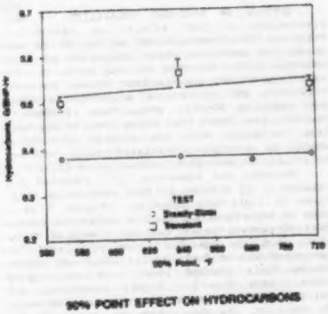


Figure 11. Effects of 90 percent point on hydrocarbon emissions: transient vs. 13-mode steady-state cycle (22).

percent point accounted for about half the variation in particulate emissions at light loads, with aromatics accounting for the other half. At higher loads, where particulate emission rates are greater, 90 percent point had little effect, and at the highest loads, a higher 90 percent point was actually correlated with *lower* particulate emissions.

The recent Chevron and Caterpillar/Mobil studies of fuel effects on emissions both examined the effects of the 90 percent point. The Chevron study (26,32) showed a slight increase in particulates with increasing 90 percent point in steady-state operation, while the Caterpillar/Mobil study (22) showed a slight decrease in particulates and hydrocarbons. More importantly, neither study showed any statistically significant effects in the transient test. The data from the Caterpillar/Mobil study are reproduced in Figures 10 and 11.

From these data, it appears that changes in back-end volatility *per se* have little effect on particulate emissions from heavy-duty DI engines, and only a minor effect on those from light-duty IDI engines. Increases in back-end volatility in commercial diesel fuels will be limited by the ASTM specification for diesel #2, and by the need to maintain acceptable cold-flow performance. Significantly decreasing back-end volatility would be very expensive, and would make achievement of other fuel-quality goals more difficult. For these reasons, consideration of an emissions-related reduction in back-end volatility of diesel fuels does not appear justified at this time.

MODELING THE COST OF REFINING CHANGES

The cost of changing the refining process to produce low-sulfur and lower-aromatic diesel fuels was modeled using a standard linear-programming (L-P) modeling technique. Two scenarios were considered: one involving low-sulfur fuel only, and the other including a reduction in aromatic content as well. Both scenarios also assumed that automotive diesel fuel would be segregated from No. 2 fuel oil, although this is not now always the case. Surprisingly, the optimal solution for the first scenario resulted in a substantial reduction in aromatic content as well, so the second scenario was modified to incorporate a small further reduction.

DESCRIPTION OF THE MODEL -- The model used for the refinery cost analysis was a version of the Department of Energy's Refinery Evaluation Modeling System (REMS). This modeling system is used by the Department of Energy (DOE) to analyze U.S. petroleum supply issues and to provide input into other energy models. REMS consists of two parts: a series of refinery LP models which simulate geographic refinery operations, and a transportation aggregator which simulates crude and product movement throughout the United States. The refinery model was designed to run separately in order to generate extreme point vectors for the refinery sector of the transportation model. Only the refinery segment of the REMS system model was used in this study.

The REMS refinery model is a single-time period linear-progam representation of crude and downstream processing and final product blending. It is similar to those typically employed by refiners for planning and scheduling, but has been simplified in some respects. It has been proven to provide a good representation of aggregate regional operations of U.S. refiners and has successfully undergone a number of validation/verification tests. The model was originally developed in 1976, at which time it was used to support analysis related to the Strategic Petroleum Reserve. It since has been used by DOE and EPA for several purposes. EPA has used the model to predict the costs of lead phasedown during the 1982 and 1984 rule-makings (33).

The model "begins" with a representation of crude oil distillation through a series of crude assays. For each of about 100 crude oils, the assays describe the yield of intermediate or final refined products generated during the initial distillation and their quality. Downstream from the crude distillation unit, the model contains comprehensive representations of all major refinery units. The downstream unit representations contain yield and cost correlations for various types and quality feedstocks as well as correlations used to determine output quality.

The model determines an optimum solution to a specified objective (such as profit maximization) based on prevailing economic conditions and as limited by capacity constraints, product specifications or other user-specified constraints. In addition to the optimum answer, the model provides economic and processing information on all aspects of the refining industry's operations, such as process utilizations or the rate at which costs change as operations are altered.

For this analysis, two regional models were developed to represent the Eastern U.S. (PADDs I through IV) and the Western U.S. (PADD V). The existing petroleum distribution network allows refiners to somewhat optimize aggregate operations through product exchanges, crude variations, etc., in each of these regions. However, there is very little connection between the West Coast and the remainder of the U.S. product distribution system; hence, the two operate independently.

For each region, projections were made of refinery supply and demand petroleum prices, product qualities and processing capacities for the year 1987. The industry was limited to processing facilities currently in place or projected to be completed by 1987; new investments beyond these were not assumed to be available within this timeframe. Each model was run with product demands fixed, except for liquid petroleum gas, coke, sulfur and residual fuel. Most inputs were also fixed, but the models were allowed to vary a marginal crude, butane and utility purchases. These initial runs defined a "base case" fore- cast of industry operation in each region with diesel fuel quality conforming to current specifications.

After establishing the base cases, the models were again run with the same raw material, product, and pricing assumptions, but with more restrictive diesel fuel specifications. Because all other parameters were held constant between cases, the cost associated with changes in diesel specifications could be computed as the sum of changes in crude oil, butane and utility purchases; LPG, coke, sulfur, and residual fuel revenues; and other marginal operating costs (catalysts, chemicals, etc.). Fixed costs and capital charges were not included in the cost computations. These latter costs are already "sunk" and will not vary with diesel fuel specifications.

The more restrictive diesel fuel specification cases first considered a reduction in sulfur content from current levels to 0.05 weight percent. Then, with the sulfur content maintained at 0.05 weight percent, diesel fuel aromatics content was lowered to 17 volume percent. In order to avoid "dumping" of high sulfur diesel fuel as #2 heating oil (which could offset the environmental benefits of low-sulfur diesel fuel) the model was constrained to keep the sulfur content of #2 heating oil constant.

MODEL RESULTS — Table 1 compares the refining cost model results for the two regulatory scenarios with those for the base case. All of the costs and volumes shown in the table are representative annual totals for the year 1988, expressed in 1985 dollars, and assuming a world oil price of $29.00 per barrel. This year was chosen as being about the earliest one in which the fuel regulations being modeled could be implemented. The costs, and especially the costs-per-gallon shown in the tables are considered to be representative of those for later years as well.

Table 1. Combined Refining Cost Model Results for the Entire U.S.

	Baseline	Scenario One	Scenario Two
Physical Properties			
API Gravity	34.0	37.5	37.9
Sulfur (weight %)	0.276	0.048	0.048
Aromatics (volume %)	28.7	20.3	17.0
Distillation Temperatures			
10 percent	421	397	395
50 percent	523	487	509
90 percent	607	598	601
Calculated Cetane Index	46.0	48.2	51.8
Volumetric energy (KBTU/gal)	131.1	129.3	129.3
Viscosity (cstk. at 38 C)	3.2	2.6	2.7
Production and Costs			
Total diesel fuel (MM gal/yr)	18,465	18,465	18,460
Change in total cost (MM $/yr)	—	216	277
Change in cost/gallon ($/gal)	—	0.012	0.015
Shadow price of diesel ($/gal)	0.765	0.779	0.784
Change in shadow price ($/gal)	—	0.014	0.019

The model results for Scenario One were somewhat surprising. As the tables show, the optimal refining strategy for producing the given quantity of low-sulfur diesel fuel also reduces the fuel's aromatic content from an average of 28.7 percent to 20.3 percent by volume. This is results in an increase in API gravity (corresponding to a decrease in density), a slight reduction in the volumetric energy content, and an increase in the calculated cetane index of the average fuel.

The change in cetane index is of limited significance — neither the cetane index nor the cetane number is a linear property, and thus the cetane index calculated from average properties is not the same as the average cetane index. Furthermore, the cetane index may differ from the cetane number by as much as two numbers. The change in this parameter probably does indicate a significant improvement in ignition quality, however, as would be expected from the sharp decrease in aromatic content.

As expected, the data for the second scenario show a further reduction in aromatic content, as well as some increase in the back-end boiling point. This results in a slight decrease in density, no change in volumetric energy content, and a substantial increase in the calculated cetane index. The result of this change would an extremely high-quality fuel on average. In addition, standardization of the aromatic content at 17 percent would greatly reduce the variation in density and ignition quality between different fuels. This would be a valuable result in itself, since it would allow for more precise calibration of the diesel combustion process.

The cost data shown in Table 1 are of two kinds. The first is the change in total refining costs resulting from each scenario and the change in average cost per gallon of diesel fuel, assuming that the difference in refining costs is allocated only to diesel fuel. This is a good measure of the social costs (the costs paid by society considered as a whole) of the refining changes in each scenario. The second type of cost shown is the change in the "shadow price" of diesel fuel calculated by the refinery cost model. If demand for diesel fuel were perfectly inelastic and fuel markets were perfectly competitive, this would be the change in the market wholesale price of diesel fuel as a result of each scenario. Since demand for diesel fuel actually is fairly inelastic and the markets are fairly competitive, this is probably a reasonable approximation of the price changes that would actually be experienced in each case.

As the Table 1 shows, the change in the shadow price calculated by the model is somewhat greater than the change in the average refining cost in each scenario. The difference is due to a decrease in the shadow price of distillate burner fuel, which is used as a "sink" for the excess aromatics removed from diesel fuel. Note that the model was not permitted to use burner fuel as a "sink" for sulfur, however.

The cost data shown in the tables reflect only the changes in refinery operating and raw-materials costs which would result from each scenario. Since the model results indicated that each scenario could be achieved using only the existing refinery capacity, no capital or depreciation charges were included in the costs. However, this accounting fails to consider the costs of minor process and piping changes which would be required to achieve this scenario. The most important of these would be the costs associated with segregating the production and distribution of diesel fuel and distillate burner fuel. These costs are expected to be small relative to the changes in operating costs presented above, but may not be negligible.

COMPARISON WITH OTHER STUDIES — The cost estimates for reducing aromatics developed in this study are considerably lower than those developed by other workers (8,32) who considered only the costs of applying a new process unit to the existing diesel fuel stream. They are comparable, however, to the results of another L-P model based study conducted by Bonner and Moore (34) and published by the American Petroleum Institute. This study indicated that the average aromatic content of diesel fuel in PADD II could be reduced to about 20 percent at virtually no cost, and to around 15 percent for less than one cent per gallon. This was accomplished by means of blending changes and segregation of distillate burner fuel from diesel oil. These estimates show the great potential for cost savings inherent in the refinery's ability to alter blending and processing parameters in order to achieve desired quality levels.

COST-BENEFIT ANALYSIS OF REFINING CHANGES

The estimated costs of producing low-sulfur and low-aromatic fuels were calculated by the refinery cost model, and are shown in Table 1. The benefits of using these fuels and the ratio of costs to benefits for each scenario are discussed below.

BENEFITS OF LOW-SULFUR AND LOW-AROMATIC FUELS -- Reducing the sulfur content of diesel fuel would directly reduce diesel emissions of SO_2 and particulate sulfates. For a 0.05 percent sulfur standard, these reductions would amount to more than 80 percent of the present total, or about 285,000 tons per year of SO_2 and about 7,000 tons per year of particulate sulfates nationwide. Since the sulfur content of diesel fuel is generally expected to increase in the future, the actual benefits might be even greater. The reduction in SO_2 emissions due to a low-sulfur standard would result in a corresponding decrease in secondary sulfate particles, acid deposition, and materials damage due to sulfur.

Reducing the SO_2 concentration in diesel exhaust gas would permit the use of more active catalysts in catalytic trap-oxidizers, making the design of catalytic traps much easier, and indirectly helping to reduce HC, CO, odor, and particulate emissions from trap-equipped vehicles. Desulfurization would thus be very helpful in meeting EPA's 1991 particulate standard of 0.25 g/BHP-hr for heavy-duty truck engines; it would probably be essential for meeting the 0.1 g/BHP-hr standard for transit bus engines.

Lower-sulfur diesel fuel would cause less corrosive wear of cylinders, rings, and bearings. This would help to increase the time between overhauls in heavy-duty engines, and would extend total engine life in both light and heavy-duty vehicles. The extent of this extension is uncertain, however. Based on the data in Figure 1, a 30 to 40 percent reduction in wear rates should result from the use of fuel containing 0.05 percent rather than the present 0.3 percent sulfur. For the cost-effectiveness calculations in this study we have assumed a 30 percent reduction in wear rate. This is quite conservative, since the average fuel sulfur content in the future is expected to be higher than 0.3 percent, and the differences in wear rates due to fuel sulfur in automotive service are probably higher than shown in Figure 1.

A lower sulfur content would help to reduce deposit formation on the pistons and other critical parts. Reduced deposit formation would also help to improve oil control, reduce oil consumption, and increase engine life. The lower aromatic content of the fuel would also reduce contamination of the oil by soot. This, combined with the reduced acid loading due to lower sulfur, should make it possible to extend oil change intervals significantly without adversely affecting wear.

The reduction in aromatics content which would result from desulfurization would also have a beneficial effect on emissions. Extrapolating from the results of the Caterpillar/Mobil study (22), we estimate that reducing the average aromatic content of diesel fuel from 28.7 to 20.3 percent (as in the first scenario) should result in a 22 percent decrease in the carbonaceous (non-sulfate) fraction of the particulate material in heavy-duty engines. Reducing aromatics to 17 percent as in the second scenario would give an estimated 31 percent reduction from the baseline, or about 9 percent more than scenario one. The data of Bykowski and coworkers (27) indicate effects of similar magnitude for light-duty engines, although this is highly engine-dependent.

The reduced aromatic content would also improve ignition quality, improving cold-starting and idling performance and reducing engine noise. The reduction in the use of catalytically cracked blending stocks should also have a beneficial effect on deposit-forming tendencies in the fuel injectors. On the negative side however, the reduced aromatics might result in some impairment of cold-flow properties, due to the increased paraffin content of the fuel. This would be alleviated to some extent by the reduction in 90-percent point in the first scenario, but exacerbated by the increase in 90-percent point in the second scenario.

Reducing fuel aromatic content would also reduce fuel density, since paraffins are less dense than aromatic hydrocarbons of similar molecular weights. This would reduce the volumetric energy content of the fuel somewhat, resulting in slight increase in volumetric fuel consumption if all other factors were to remain equal. On the other hand, the improved and more consistent ignition quality of the fuel would make it possible to improve fuel efficiency somewhat through better calibration, at least in new or newly rebuilt engines. This could be done by small timing improvements to optimize NO_x control for the higher-cetane fuel, and by slightly reducing the compression ratio. In addition, the improved cold-starting capability of the higher-cetane fuel would reduce fuel wastage in cold start and warmup operations. Thus the overall effects on fuel economy could be either positive or negative, but would probably not be large in either case.

COST-BENEFIT ANALYSIS -- Tables 2 through 4 contain approximate comparisons of the fuel, maintenance, depreciation, and other costs of operation for the baseline case and for each of the two scenarios discussed above. Tables 2 and 3 apply to an urban medium-heavy duty truck and a heavy-heavy line-haul truck, respectively, while Table 4 applies to a light-duty truck or passenger car. In making these calculations, the price changes for each scenario shown in Table 1 have been increased by 0.3 cents per gallon to allow for the cost of segregating diesel from burner fuel, and for possible overoptimization by the model. It should be noted that the cost and emissions changes and the cost-effectiveness values in both tables are shown as the incremental changes from the baseline to Scenario One, and from Scenario One to Scenario Two.

For the first scenario, Tables 2 through 4 indicate that substantial net benefits would accrue from desulfurization and dearomatization of diesel fuel, even excluding consideration of any emissions benefits. In addition to the benefit to society at large from reduced emissions, improved fuel quality would directly benefit vehicle owners through reduced maintenance costs and increased engine lifetime. These maintenance benefits alone are several times as great as the increase in fuel cost. Thus, from both the social standpoint and that of the individual user, desulfurization of diesel fuel as in Scenario One appears to be a highly desirable.

Scenario Two calls for additional dearomatization beyond the level in Scenario One. This would result in a slight further increase in fuel costs, and a further reduction in carbonaceous particulate emissions. If the Caterpillar/Mobil data can be extrapolated to engines in use, the incremental cost-effectiveness of this further step would be about $1.20 (for a heavy truck) to $1.74 (for a passenger car) per pound of particulate material removed. This calculation assigns no value to the reduction in hydrocarbon emissions which would result, or to the reduced noise and improved cold-start performance of the low-aromatic fuel. For comparison, EPA (35) has estimated the incremental cost-effectiveness of the new 1991 particulate emissions standard for heavy-duty engines at $5.80 to $6.80 per pound.

The values shown in Tables 2 through 4 are highly approximate, but they can be considered to be reasonable estimates. If anything, the benefit estimates are somewhat conservative, in the sense that they have tended to err toward understating benefits where these were doubtful. It should be borne in mind, however, that many of the estimated effects shown are based on incompleted data, and should thus be interpreted cautiously. The tables also fail to account for some difficult-to-quantify benefits, such as reductions in injector deposits and improvements in cold starting performance.

Table 2. Fuel Costs, Maintenance Benefits and Cost-Effectiveness of Fuel Regulations for a Typical Medium-Heavy Truck.

	Baseline	Scenario One	Scenario Two
Fuel and Maintenance Costs			
Lifetime mileage	[illegible]	[illegible]	[illegible]
Miles/year	[illegible]	[illegible]	[illegible]
Discount rate	10%	10%	10%
Fuel economy (mpg)	[illegible]	[illegible]	[illegible]
Fuel cost ($/gal)	[illegible]	[illegible]	[illegible]
Annual cost	[illegible]	[illegible]	[illegible]
Oil change frequency (mi)	[illegible]	[illegible]	[illegible]
Cost of oil change ($)	[illegible]	[illegible]	[illegible]
Total annual cost	[illegible]	[illegible]	[illegible]
Engine cost (new) ($?)	[illegible]	[illegible]	[illegible]
Equivalent annual cost	[illegible]	[illegible]	[illegible]
Mileage to overhaul	[illegible]	[illegible]	[illegible]
Cost of overhaul	[illegible]	[illegible]	[illegible]
Equivalent annual cost	[illegible]	[illegible]	[illegible]
Total annual cost	[illegible]	[illegible]	[illegible]
Change from previous		[illegible]	[illegible]
Emissions and Cost-Effectiveness			
Particulates (g/BHP-hr)			
Carbonaceous	0.75	0.30	0.33
Direct sulfate	0.05	0.01	0.01
Total direct part.	0.80	[illegible]	[illegible]
BHP-hr per mile (PB)	[illegible]	[illegible]	[illegible]
Direct part. (g/mile)	[illegible]	[illegible]	[illegible]
SO_2 emissions (g/mile)	[illegible]	[illegible]	[illegible]
Indirect part. (g/mile)	[illegible]	[illegible]	[illegible]
Total part. (g/mile)	[illegible]	[illegible]	[illegible]
Total annual part. (lb)	[illegible]	[illegible]	[illegible]
Reduction from prev. (lb/yr)		[illegible]	[illegible]
Cost-effectiveness ($/lb)		[illegible]	[illegible]

Table 3. Fuel Costs, Maintenance Benefits and Cost-Effectiveness of Fuel Regulations for a Typical Line-Haul Truck.

	Baseline	Scenario One	Scenario Two
Fuel and Maintenance Costs			
Lifetime mileage	[illegible]	1,000,000	1,000,000
Miles/year	100,000	100,000	100,000
Discount rate	10%	10%	10%
Fuel economy (mpg)	[illegible]	[illegible]	[illegible]
Fuel cost ($/gal)	1.130	1.145	1.148
Annual cost	[illegible]	[illegible]	[illegible]
Oil change frequency (mi)	[illegible]	17,000	17,000
Cost of oil change ($)	[illegible]	[illegible]	[illegible]
Annual cost	[illegible]	[illegible]	[illegible]
Engine cost (new) ($?)	[illegible]	[illegible]	[illegible]
Equivalent annual cost	[illegible]	[illegible]	[illegible]
Mileage to first overhaul	[illegible]	700,000	700,000
Cost of overhaul	[illegible]	[illegible]	[illegible]
Equivalent annual cost	[illegible]	[illegible]	[illegible]
Mileage to second overhaul	[illegible]	[illegible]	[illegible]
Cost of overhaul	[illegible]	[illegible]	[illegible]
Equivalent annual cost	[illegible]	[illegible]	[illegible]
Total annual cost	[illegible]	[illegible]	[illegible]
Change from previous		[illegible]	[illegible]
Emissions and Cost-Effectiveness			
Particulates (g/BHP-hr)			
Carbonaceous	0.75	0.30	0.33
Direct sulfate	0.05	0.01	0.01
Total direct part.	0.80	[illegible]	[illegible]
BHP-hr per mile (PB)	[illegible]	[illegible]	3.12
Direct part. (g/mile)	[illegible]	[illegible]	[illegible]
SO_2 emissions (g/mile)	[illegible]	[illegible]	[illegible]
Indirect part. (g/mile)	[illegible]	[illegible]	[illegible]
Total part. (g/mile)	[illegible]	[illegible]	[illegible]
Total annual part. (lb)	[illegible]	[illegible]	[illegible]
Reduction from prev. (lb/yr)		[illegible]	[illegible]
Cost-effectiveness ($/lb)		[illegible]	[illegible]

Table 4. Fuel Costs, Maintenance Benefits and Cost-Effectiveness of Fuel Regulations for a Typical Light-Duty Car or Truck.

	Baseline	Scenario One	Scenario Two
Fuel and Maintenance Costs			
Lifetime mileage	100,000	130,000	130,000
Miles/year	15,000	15,000	15,000
Discount rate	10%	10%	10%
Fuel economy (mpg)	28	28	28
Fuel cost ($/gal)	1.130	1.145	1.148
Total annual cost	$605	$613	$615
Oil change frequency (mi)	3,000	6,500	6,500
Cost of oil change ($)	$20	$20	$20
Annual cost	[illegible]	$46	$46
Engine cost (new)	$4,000	$4,000	$4,000
Equivalent annual cost	[illegible]	$711	$711
Total annual cost	[illegible]	$1,371	$1,373
Change from previous		($145)	$2
Emissions and Cost-Effectiveness			
Particulates (g/BHP-hr)			
Carbonaceous	0.31	0.24	0.21
Direct sulfate	0.04	0.01	0.01
Total direct part.	0.35	0.25	0.22
SO_2 emissions (g/mile)	0.80	0.11	0.11
Indirect part. (g/mile)	0.73	0.11	0.11
Total part. (g/mile)	1.08	0.36	0.33
Total annual part. (lb)	36	12	12
Reduction from prev. (lb/yr)		23	1
Cost-effectiveness ($/lb)		(6.27)	1.74

SUMMARY AND CONCLUSIONS

This study has examined the feasibility, costs, and maintenance benefits of two possible diesel fuel quality regulations, and has examined their cost-effectiveness for emissions control. The following conclusions can be stated.

1. The most important emissions-related properties of diesel fuel are the sulfur content and the aromatic hydrocarbon content. Reducing fuel sulfur would reduce SO_2 emissions and the sulfate fraction of diesel particulates, and would indirectly reduce ambient levels of sulfate particles and acid deposition. Reducing fuel aromatic content would reduce hydrocarbons and the carbonaceous fraction of diesel particulate emissions. Contrary to common belief, changes in the distillation temperatures (such as the 90 percent point and end point) have little potential for emissions control.

2. It would be feasible to reduce the sulfur content of automotive diesel fuel from the present average of about 0.3 percent to 0.05 percent by weight. This could be done without reducing the availability of diesel fuel, and would require little or no addition to the present refinery capital stock. This

could be accomplished by segregating production of diesel fuel from that of distillate burner fuels, and by using existing desulfurization capacity more intensively. The increase in average refining cost due to desulfurization would be about 1.2 cents per gallon.

3. Re-optimization of the refining process to reduce diesel fuel sulfur to 0.05 weight percent would also result in a decrease in the average aromatic content of diesel fuel, from the present 28.7 percent to 20.3 percent by volume. Since refinery processes differ, this reduction would not be seen in every refinery. In order to minimize variations in ignition quality, a separate limit on aromatics content would be desirable. The cost of such a limit would be small if it were set somewhat above the predicted average aromatic content.

4. Reducing the sulfur content of diesel fuels would reduce corrosive wear and oil fouling and would extend engine life. These benefits are difficult to quantify due to a lack of applicable quantitative data. However, a conservative estimate based on the limited data available indicates that the maintenance savings due to reducing sulfur to 0.05 percent would be about four times the increase in refining costs which would result. Substantial reductions in SO_2 emissions and ambient sulfate particles would also result from the reduced sulfur content.

5. The lower aromatic content of the low-sulfur fuel would improve cetane numbers and ignition quality, which would aid cold starting and reduce noise, and might make possible changes in engine design and calibration that would improve fuel economy slightly. The reduction in aromatics would also result in roughly a 22 percent decrease in carbonaceous particulate emissions from heavy-duty diesel engines, and a reduction in hydrocarbon emissions as well. The reduction in light-duty particulate and HC emissions is uncertain, but would probably be similar.

6. It would be feasible to reduce the aromatic content of diesel fuel below the level attained with desulfurization. An aromatic content of 17 percent could be achieved using the present capital stock, at a cost of about 0.4 cents per gallon beyond the cost of low-sulfur fuel. This would result in minor further improvements in cold starting and other performance characteristics, but might cause cold flow problems at low temperatures. Carbonaceous particulate emissions would be reduced by about a further nine percent of the baseline. The incremental cost-effectiveness of particulate control by this means would be about $1.30 (for heavy trucks) to $1.79 (for passenger cars) per pound of particulate matter eliminated. This is substantially lower than EPA's estimate of the incremental cost effectiveness of its 1991 heavy-duty diesel particulate standard.

ACKNOWLEDGEMENTS

Funding for this work was provided by the U.S. EPA under contract 68-01-6543. The EPA Project Officer for this work was Mr. Willard Smith of the Office of Policy Analysis.

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Printed in U.S.A.

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May 1, 1986

Honorable Henry A. Waxman
Chairman
Subcommittee on Health and the Environment
2415 Rayburn House Office Building
Washington, D.C. 20515

Dear Mr. Chairman:

I am pleased to submit the enclosed statement of the American Society of Mechanical Engineers on acid deposition and request that it be made a part of the record of the hearings on H.R. 4567 conducted by the Subcommittee on Health and the Environment, April 29 and 30, 1986.

Although the statement addresses the topic of acid deposition in general, I believe it will be useful in the Subcommittee's review of the pending acid rain legislation.

The causes and effects of acid deposition are extremely complex and not well understood. Until the emission-source to receptor-effect relationships are better understood, there is no certainty that rollbacks in emissions of sulfur and nitrogen oxides will appreciably curtail acidification of surface waters or halt forest decline attributed to acid deposition.

The Council on Environmental Quality's annual report indicates that there has been a decline in SO_2 ambient concentration since 1970. This would suggest there should be an improvement in the pH of rainfall if SO_2 was the cause of acid deposition. Yet acid rainfall collection networks have not shown any change in the pH of rainfall in the past few years.

Therefore, because of the uncertainties that remain, we believe Congress should proceed in a more cautious fashion and not legislate a costly program, which will ultimately be paid for by consumers, when the benefits of such a program are not certain.

Sincerely,

George C. Wiedersum, Jr.
Vice President
Environment and Transportation Technical Group

PWH/GCW:lh
1204A
Enclosure

General Position Paper
On
ACID DEPOSITION

I. EXECUTIVE SUMMARY

The causes and effects of acid deposition are extremely complex issues which are not well understood. Current scientific knowledge is inconclusive about the relationship between man-caused atmospheric acid deposition and increased acidity of surface waters. The effects of man-caused acid deposition have not been sufficiently distinguished from the effects of natural sources of acidity. Factors such as soil conditions, forest litter, and land and water management, significantly affect water quality, including acidity.

Until the emission-source to receptor-effect relationships are better understood, there is no certainty that rollbacks in emissions of sulfur and nitrogen oxides into the atmosphere will appreciably curtail acidification of surface water or halt forest decline attributed to acid deposition. [1,2] **Therefore, legislation to arbitrarily rollback emissions should not be enacted because it would require spending of billions of dollars with little assurance that there would be a commensurate mitigation effects possibly resulting from acid deposition.**

Because the effects attributed to acid deposition are potentially serious threats to the natural environment, Congress should:

1. **Continue to provide funding and critical assessment for research on acid deposition;**
2. **Continue the establishment of a long-term data base to assess trends;**
3. **Support clean coal demonstration projects;**
4. **Implement interim liming of sensitive lakes; and**
5. **Support research on combustion processes; and**
6. **Take other actions discussed in this paper.**

There are promising sulfur and nitrogen oxide emission control technologies now under development. Congress should establish goals and objectives, but it should not mandate the use of any particular control technology.

BACKGROUND

While there is plenty of information available about acid deposition and its effects, it is important to recognize that additional scientific knowledge about atmospheric chemistry, long-range transport, and acid deposition needs to be developed and confirmed.

The following points summarize the current state of scientific knowledge about acid deposition:

* Acid deposition in rain, fog and snow and as "dry deposition," consists largely of sulfur and nitrogen oxides (SO_x and NO_x), which come from a variety of natural and man-made sources. Anthropogenic sources include electric power plants, industrial facilities, transportation, waste combustion and space heating systems.[3]

* About two-thirds of the man-made emissions of sulfur oxides to the atmosphere of the U.S. are from plants bordering on and east of the Mississippi River. About 80% of the emissions from this area come from coal-burning power plants, mostly located in the Mississippi, Tennessee and Ohio River valleys. Many of these plants predate the New Source Performace Standards requirements of the Clean Air Act.[4,5]

* Emissions of nitrogen oxides are generated from many stationary and mobile sources nationwide and vary from region to region in the ratio between stationary and mobile sources.[2,6] Large urban areas with the high density of automotive traffic make a significant NO_x contribution to the ambient air.

* Increases in the acidity of some surface waters in the Northeastern United States and Florida have possibly occurred in recent years. Today, less than five percent of the total water area in these regions is sufficiently acidic to affect the fish population. It is also believed that sulfates and nitrates play a significant role in this acidity.

* The relationship between man-caused acid deposition and increased acidity of surface water is not well understood and needs to be distinguished from natural sources of acidity and impacts on surface waters unrelated to acid deposition.[7] Factors such as soil and rock conditions, forest litter, land, forest and water management and use significantly affect water quality, including acidity, and the biological species in the water.[8] The sulfur and nitrogen from acid deposition represent only a small fraction of these materials cycling in many watersheds, and it is not known whether even the most sensitive watersheds have been significantly affected by man-caused changes in atmospheric deposition.[1,2] Other man-caused pollution such as particulates and photochemical oxidants (measured as ozone) may also affect the acidity of watersheds.

* The longest continuous historical record of acid precipitation data is from Hubbard Brook, N.H. These data indicate no evidence for a strong linearity in

the relationship between long-term average depositions and emissions in Eastern North America. In addition, while SO_2 emissions and concentrations in the atmosphere of the Eastern U.S. have been diminishing since 1970, precipitation data does not indicate a corresponding reduction in acidity.[9]

* The United State Geological Survey (USGS) Acid Rain Monitoring Network which began operating in New York in the foothills of the Adirondacks in 1965, shows approximately the same ph in 1965 as in 1983. Most significantly, the data does not show any improvement or change in the ph of rainfall due to the 1970 and 1977 Clean Air Act/State Implementation Plans reductions in SO_2 emissions.

RECOMMENDATIONS

1. The ecological effects attributed to acid deposition may pose serious threats to the natural environment. However, until the emission-source to receptor-effect relationships are better understood and scientifically quantified, there is no assurance that rollbacks in emissions of sulfur and nitrogen oxides into the atmosphere--or any other controls on man-made pollution--will help improve the acidification of surface waters or halt forest decline attributed to acid deposition. Therefore, we oppose legislation to arbitrarily roll back emissions because it would cost billions of dollars with little assurance that there would be a commensurate mitigation of acid deposition or its effects.

2. The Federal government should support research and critical assessment of the research required to:

a. Define the role and relative contribution of SO_x, NO_x, ammonia, ozone, particulate matter and oxidants with regard to acid deposition;

b. Determine long-term trends in acid deposition and their potential effects; and

c. Investigate all other potential causes of acidity and other ecological changes in watersheds and forests, including soil conditions, forest litter, forest, land and water management, and metals.

d. Improve knowledge of combustion processes for SO_2 removal.

e. Define the relative role of automobile emissions with respect to acid deposition; including the impacts resulting from the lead phase-out and lead substitutions for gasoline.

3. EPA should establish and maintain a long-term high quality data base to assess trends and monitor the impact of any control strategy, through increased atmospheric sampling and monitoring.

4. Since coal will be one of the major energy sources of the future, Congress should continue to support funding of the Clean Coal Technology Reserve established in 1984 to support clean coal combustion demonstration projects, to determine the most environmentally and cost effective methods of coal utilization.

Mechanical engineers in industry, government and academia are continuously working on more efficient means to utilize coal with minimum environmental impact. Developing technologies include fluidized bed combustion, Limestone

Injection Multi-Stage Burners and other in-furnace sulfur capture techniques; coal gasification/combined cycle plants, advanced coal cleaning processes, slagging combustors, advanced SO_2 and NO_x flue gas cleaning systems, and others. These technical advances may be applied in future new plants and, to a limited extent, in existing plants. With all the promising technological advances, Congress may establish goals and objectives on a control program, but it should not mandate a specific control technology.

5. Implement on an interim basis for selected most sensitive surface ecosystems, measures demonstrated to be beneficial and cost effective in the mitigation of acidification. Such measures include liming of lakes which is known to be effective in the short term in most circumstances. Other potential measures such as removal of excess acid-producing organic litter by controlled forest burning should be investigated.

6. Congress should appropriate funds to study the cost/benefit of decreasing emissions of NO_x and SO_x from mobile sources through additional fuel desulfurization and fuel substitution with, for example, methanol, as well as other methods.

7. Non-polluting forms of power generation, in particular, nuclear power, offer the potential to reduce environmental impacts. Congress should examine nuclear licensing reform and other factors presently inhibiting the construction of new nuclear power plants.

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ASIA

AUTOMOTIVE SERVICE INDUSTRY ASSOCIATION THE INDUSTRY'S ONLY FULL SERVICE ASSOCIATION
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JOHN W. NERLINGER, CAE
President

May 5, 1986

The Honorable Henry Waxman, Chairman
Subcommittee on Health and the Environment
2415 Rayburn House Office Building
Washington, D.C. 20515

Dear Chairman Waxman:

We respectfully request the enclosed statement on H.R. 4567, "The Acid Deposition Control Act of 1986," be included in the hearing record.

Although warranty provisions such as those contained in H.R. 2169 by Representative Dannemeyer are not included in H.R. 4567, we strongly believe any meaningful revision of the Clean Air Act should include such warranty reduction language. Especially, since the Senate Acid Rain measure, S. 2203, by Chairman Stafford does contain warranty language. It would be most unfortunate if the House did not address this issue and went to a House-Senate Conference on any measure without a considered position.

We appreciate your consideration of this request.

Sincerely,

John W. Nerlinger

John W. Nerlinger

JWN:cs

Enclosure

cc: Members, House Subcommittee on
Health and the Environment

STATEMENT OF JOHN W. NERLINGER
PRESIDENT, AUTOMOTIVE SERVICE INDUSTRY ASSOCIATION
TO
HOUSE SUBCOMMITTEE ON HEALTH AND ENVIRONMENT
OF THE HOUSE COMMITTEE ON ENERGY AND COMMERCE

RELATING TO H.R.4567 - ACID DEPOSITION CONTROL ACT OF 1986

Mr. Chairman, members of the Committee:

My name is John W. Nerlinger. I am president of Automotive Service Industry Association (ASIA), the organization representing the entire automotive aftermarket industry. The association appreciates this opportunity to present its views on H.R.4567, the Acid Deposition Control Act of 1986 and to express its support for amendment of that bill to include provisions of H.R.2169, introduced by Representative Dannemeyer.

H.R.2169 would amend the Clean Air Act to promote competitiveness in the automotive aftermarket and to preserve consumer freedom of choice to select auto parts and service by changing the emissions warranty provisions of current law.

The Automotive Service Industry Association (ASIA) is the automotive world's largest and most comprehensive organization. Its membership encompasses more than 8,500 independent automotiv wholesalers, warehouse distributors, heavy-duty parts and

equipment distributors, automotive electric service distributors, manufacturers' representatives, manufacturers and remanufacturers of automotive parts, tools, equipment, chemicals, paint, refinishing materials, supplies and accessories. Members of the association are primarily small businesses engaged in manufacturing and distributing the replacement parts and accessories that are required to service and repair the millions of passenger cars and trucks in operation in the United States today.

The parts and components necessary for the repair and maintenance of these millions of motor vehicles are primarily supplied by independent manufacturers and distributors, which are collectively known as the independent aftermarket industry. This parts and service industry, composed of over 400,000 independent businesses, the vast majority of which are small business, occupies a vital role in maintaining the nation's vehicles and in protecting the environment.

Mr. Chairman, you and the members of the Committee are to be commended for your unrelenting and tireless efforts to protect and to preserve our environment. The independent automotive aftermarket also places a high priority on such protection. Over the years, the independent aftermarket has made a significant contribution to the protection and preservation of the environment by providing a convenient, efficient and low cost opportunity to make the necessary repairs and to perform the necessary maintenance on the millions of motor vehicles traveling the nation's highways. The consumer has overwhelmingly chosen to use the independent aftermarket where a free choice to do so has presented itself. The result is that our air quality is better than it would be if they did not so freely exercise their choice for that efficient and convenient service.

Getting the right parts to the right person at the right time and at the right place at a competitive and affordable price is the mission of the independent aftermarket. It is a mission that serves the consumer very well. Competition in the marketplace breeds efficiency and that efficiency allows the industry to provide the double convenience of affordable cost and immediate service.

Now however, the consumer and this vast independent industry face a serious crisis. The competitive structure of the industry and therefore the highly efficient and affordable service it provides is under attack. The point of attack originates from a highly unexpected source.

It is one that is self-defeating and highly destructive. We refer to the monopolistic 5 year, 50,000 mile performance warranty interpreted by the EPA to cover a wide range of parts, a warranty that is being accepted by the vehicle manufacturers as a fact of life that imposes few additional economic burdens on them but as one which opens up new vistas of a government mandated and approved monopoly in an industry that has heretofore successfully served the public so well primarily because of competition and the absence of any such monopoly.

The issue raised by this long-term performance warranty is not environmental --- it is an economic issue --- it is a question of monopoly as opposed to free enterprise. It is an issue that springs from the language of the Clean Air Act and the EPA interpretation of that language.

In 1977 Congress attempted to strike a careful balance between the environmental benefits and the anticompetitive drawbacks of a mandated 5 year, 50,000 mile warranty by amending the Clean Air Act to reduce the warranty to 2 years or 24,000 miles on all parts other than those placed on or in a vehicle for the sole or primary purpose of reducing vehicle emissions. While recognizing that any mandated warranty distorts the marketplace and deprives the consumer of freedom of choice in selection of parts and services, the independent aftermarket nevertheless was prepared to live with a reduced warranty since it more closely conformed to the actual economic realities of the marketplace exercised on a voluntary basis by the industry.

The EPA performance warranty regulations issued in 1980 ignored the mandate of Congress and rolled back the 5/50 situation to the pre-1977 amendment days.

The EPA performance warranty regulations establish an overly long, broad based performance warranty that ignores Congressional intent to avoid anticompetitiveness and establishes a current monopoly mandated by law in the vehicle manufacturers for parts and services by effectively denying to the independent automotive aftermarket access to the vehicle until after 5 years or 50,000 miles.

In its bureaucratic zeal, the EPA liberally and loosely used the term "primary purpose of reducing vehicle emissions" and contended that what Congress really meant when it inserted that term was that a whole laundry list of parts be included in the warranty obligation for 5 years or 50,000 miles.

Claiming that Congress, although it was obviously acting to reduce the scope of warranty coverage in 1977 did not really mean to do so, the EPA effectively wiped from the statute books the protective language enacted by Congress in 1977.

The most flagrant abuse of regulatory process by EPA was its broadened definition of an emission control device or system. The EPA regulations provide that the term includes, but is not limited to a list attached to the warranty regulations that is entitled "5 year/50,000 Mile Performance Warranty Parts List".

That list ranges from the air/fuel metering system, through the ignition spark/retard system, evaporative emission control system, PCV system, air injection system, catalytic and thermal reactor system, electronic engine controls and hoses, clamps, brackets, pipes, gaskets, belts, seals, connectors used in such systems. EPA states that it will from time to time publish lists containing additional parts.

By regulation, and not by legislative enactment, the EPA thus established an overly long, broad-based warranty that ignored Congressional intent to avoid anticompetitiveness and established a monopoly mandated by law in favor of the vehicle manufacturers.

It is submitted that such a mandated long length, broad based warranty is not needed in order to protect the environment. The requirements for protection of the environment are met by maintaining in the Act the provisions for durability certification through mandatory recall provisions. Thus, the mandate of an overly long broad-based warranty takes on the character of an imposition of economic control that is not related to or necessary for the attainment of desired clean air objectives.

The existence of a warranty has historically forced the vehicle owner back to the vehicle dealer, not only for warranty work but also for routine maintenance work, such as spark plug replacement. It is only human nature to refuse to risk the loss of something of potential value that has been paid for in the original price of the vehicle.

Studies conducted in the 1960's, during the time vehicle manufacturers initiated voluntary 5 year/50,000 mile warranties, showed a significant drop in the independent aftermarket share of the replacement market even for those parts and services that were not specifically covered by the extended warranties.

The question of an environmental need (as opposed to an economic objective) for a warranty must be addressed. In its own studies, the EPA has found that most vehicles failing an emissions test do so because of improper maintenance, removal of components by the owner or use of leaded gasoline. In the vast majority of cases, therefore, the system does not come under the terms of a performance warranty. What then can be accomplished by imposition of a requirement for a warranty offering that does so little for the environment but is so economically devastating to the aftermarket and to the consuming public?

The requirement for such an unreasonably long-term broad-based warranty imposes a veritable death sentence on the competitive structure of the automotive aftermarket. The adverse economic effect of such an unnecessary warranty obligation on the independent automotive aftermarket seriously impedes the effectiveness of that industry to accomplish its role in the preservation and protection of the environment.

The issue is economic, not environmental. It is monopoly over free enterprise. The issue must be decided based upon principles of competition and in light of our historical national opposition to monopoly. Our industry fought hard for the 1977 amendments to the Clean Air Act. Congress believed in us and we in it. Upon enactment of the amendments, it was assumed by all that competition had been preserved and the environment fully protected by the limitation of the performance warranty after 2 years/24,000 miles to those limited parts that are placed on a vehicle for the sole or primary purpose of controlling emissions.

It is submitted that now is the time to evaluate the consequences of any type of mandated warranty to the aftermarket industry and to the consumer. There is no environmental need nor is it economically desirable to "seal the hood" of a vehicle and prevent the vehicle owner from obtaining parts and services when and where he needs them and at competitive prices determined by free marketplace conditions.

H.R.2169, introduced by Representative Dannemeyer provides the opportunity for Congress to reassert its determination to protect competition as well as the environment. It provides for a realistic term for a warranty on parts that are necessary for environmental protection. The length of the warranty is sufficient to produce assurances of durability of emission systems but is not any longer than it needs to be. It provides the consumer with environmental protection along with preserving

freedom of choice. ASIA strongly supports this bill and urges amendment of H.R.4567 to include the pertinent language of H.R.2169 with respect to the emission warranty.

Thank you for giving us this opportunity to express our views on this important matter.

Very truly yours,

John W. Nerlinger
President
Automotive Service Industry
Association

IASA

May 7, 1986

The Honorable Henry Waxman, Chairman
Subcommittee on Health and the Environment
2415 Rayburn House Office Building
Washington, D.C. 20515

Dear Mr. Chairman:

IASA respectfully requests this letter be made part of the hearing record on H.R. 4567, "The Acid Deposition Control Act of 1986."

The Independent Automotive Service Association is headquartered in Bedford, Texas and is comprised of approximately 5,000 independent mechanical and collision repair facilities nationwide.

IASA strongly believes any Clean Air Act revisions should also consider the anticonsumer and anticompetitive impacts of the Clean Air Act's warranty provisions. This is an issue that has been discussed by your Subcommittee and the full Energy and Commerce Committee on previous occasions. In 1984, numerous revisions to the warranties were included in the mobile source provisions agreed to by the Committee. As you know negotiations on the legislation broke down over stationary source issues.

In 1977, Congress recognized that the Clean Air Act should be amended in order to protect the small aftermarket businessman and the consumer from the anticompetitive emission warranties contained in the Act. Language that would prevent a vehicle manufacturer "monopoly" in parts and service were enacted into law. Parts to be warranted for the extended 5/50 warranty period as required in the Act were limited to those installed primarily to control emissions.

EPA then expanded the list of parts covered under the warranty by regulatory means. They justified their actions by stating in the Federal Register, that Congress couldn't have possibly meant to do what it did when it limited the scope of parts subject to the extended warranty.

Although H.R. 4567 does not include warranty language, it is important to note that S. 2203 by Senate Environment and Public Works Committee Chairman Robert Stafford contains such language. It would be unfortunate for the House to ignore these anticonsumer and anticompetitive provisions in the law and then arrive at a House-Senate conference on the Act with no considered position.

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In the past, the House has addressed the warranty issue and concluded it was an "economic" one of major import to both consumers and the independent automotive aftermarket. This "economic" issue evolved solely from the wish of some to mandate supposed "durability" on vehicle manufacturers. In fact, this has turned out to be more detrimental than beneficial. EPA studies show most vehicle failures are caused by consumer tampering, misfueling, or removal of emissions control components. It is certainly not a "durability" question.

The warranties contained in the Act serve as a significant barrier to the competitive nature of the auto repair industry. Independent service facilities have done 75 to 85 percent of the service work on vehicles across this nation, by consumer choice, after the "marketing warranty", offered by the vehicle manufacturer as a sales incentive, has expired. A few vehicle manufacturers offer marketing warranties of longer duration (some 5 years/50,000 miles) which are very restrictive in their coverage and often times require a deductible be paid by the consumer.

With the expansion of emissions inspections across the nation, consumers are becoming more and more aware of their Clean Air Act warranties. Should they fail an inspection they naturally return their vehicles to the vehicle manufacturer, hoping upon hope, that whatever is wrong is covered by a warranty. As long as the consumer believes he has some "possible" protection under a warranty, he will return to the franchised dealer in hopes of obtaining "something for nothing." To their surprise a vast number of consumers will find they have inadvertantly voided their emissions warranty by working on the car themselves or by using independent parts or services prior to their emissions warranty claim.

Section 207(c) of the Act gives the EPA all the authority necessary to mandate vehicle manufacturer recalls of any defective emissions control component for 5 years/50,000 miles, without the anticompetitive impact of the warranties. This gives the consumer the protection he needs and the durability Congress desired, without going against his proven preference for maintenance of the vehicle at independent repair facilities, rather than franchised dealers.

Representative Dannemeyer's warranty language was accepted by the Energy and Commerce Committee during its consideration of H.R. 5252. It is unfortunate that measure died over stationary, not mobile source issues. Mr. Dannemeyer's measure, H.R. 2169, is identical to that adopted by the Committee in H.R. 5252. It provides for a reduction of the warranties to 2 years/24,000 miles which is more comparable to what the consumer is offered as a marketing sales incentive warranty by vehicle manufacturers.

It is difficult to understand why so many ignore the "facts" on this issue and favor the "perceptions." The reality is, the Clean Air Act warranties provide the consumer with absolutely nothing, but rather limit his right to work on the vehicle himself, and his choice of where the vehicle is serviced during its mandated 5 year/50,000 mile warranties. They do not mandate extended durability -- that's taken care of by section 207(c) recall. Additionally, the warranties are even more meaningless in areas without an I/M program to "trigger" them. The 207 (c) recall provisions for emission component failures apply to every vehicle whether or not it is in an air quality control region, or subject to an emission inspection. The recall provisions function with much less anticompetitive impact than do the warranties.

For years the independent service industry has won, hands down, in competing with the vehicle manufacturer's franchise dealer. Should the Federally mandated monopoly of the Clean Air Act warranties be allowed to continue, that consumer choice will be more and more restricted. Consumers will be forced to return the vehicle for all parts and service to the franchised dealer during the time it is covered by Clean Air Act warranties.

H.R. 2169 would have absolutely no adverse impact on "clean air" or protections afforded the consumer. It is solely an economic issue -- one of dollars -- in which Congress has mandated a "monopoly" for one segment of an industry that has been unable to obtain that a monopoly in open competition for the last 50 years.

IASA respectfully urges the inclusion of H.R. 2169 by Representative Dannemeyer in any clean air measure considered by the House. We appreciate this opportunity to present our views. Should you have any questions regarding the positions taken in the statement, please contact our Washington Representative, Richard Turney, at 331-9825.

Sincerely,

Allen Richey

Allen Richey
Executive Director

AR:vb

cc: Members of the Health & Environment Subcommittee

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